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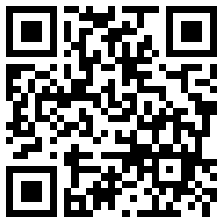

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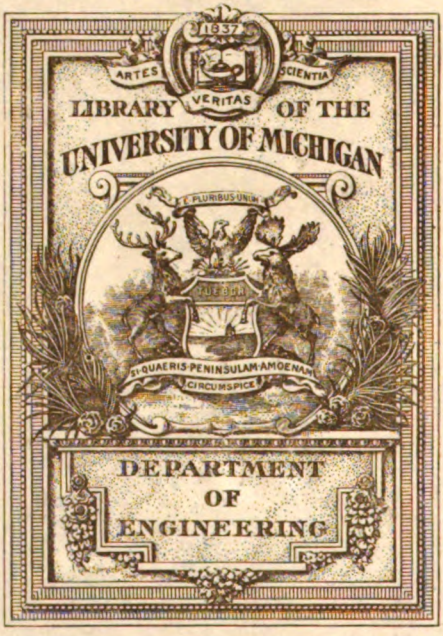

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ALASKA, the bleak territory belonging to the United States, and occupying the north-west portion of the North American Continent, is a rich country whose development is proceeding apace. Hitherto, owing to short seasons and lack of transportation facilities, colonisation has progressed very slowly, but now that the United States Government has realised its great possibilities we may expect the march of progress to be rapid. Hundreds of miles of railway are at present in the process of construction and in a few years will be carrying great freights, for, besides the mineral resources of the territory, which have only been developed in part, there are important agricultural districts which experts have calculated to be capable of supporting a population of no less than 5,000,000, engaged in dairy farming and grazing alone. It will thus be seen that Alaska is a country with a great future.

Of course, in a newly developed country progress is impossible without rapid means of communication. Usually the wire telegraph supplies the greater part of such needs, but in Alaska conditions are peculiar. It has been said that the country contains every topographical and geographical formation known to man, and tremendous natural difficulties have to be overcome in the construction of telegraph lines and the laying of cables across stretches of water.

Along the coast volcanic disturbances are frequent, and although these in a great majority of cases are only slight, yet they are sufficiently troublesome to cause almost continuous interruption of the cable service. It must be remembered that after a cable fault has been located a specially designed repair ship needs to be despatched to the spot, and during bad weather delays are bound to be prolonged. Wireless telegraphy has, of course, numerous advantages over the landline and submarine cable service for such a country, and it is not surprising that full use is now being made of it by public and private interests. The Government, through the navy and military departments,

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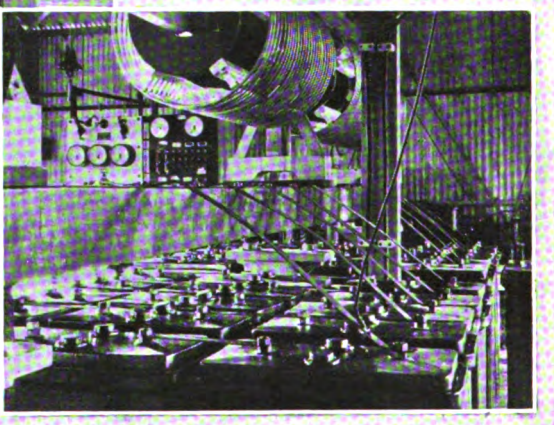
have established wireless stations at convenient points throughout the territory, and as a result places hitherto unserved are connected by a well-organised system.

Numerous mining and canning companies have secured Marconi installations, and by their help are able to keep in touch with the outside world. In pre-Marconi days a great deal of time was wasted in communication, for it was often necessary to send messages by boat from the mine to the nearest telegraph office.

Two years ago the Marconi Company decided to extend its activities in Alaska, and to-day has semi-high-power stations at Ketchikan, the first port of entry into Alaska, and at Juneau, the capital. A similar station has also been erected at Astoria, in the United States, and between this place and Juneau a large amount of traffic passes. These stations were put into commission last July, and the reliable day and night service has proved of the greatest use to commercial interests. As an example of its value, it may be mentioned that

TWENTY-WIRE AERIAL TERMINAL AT KETCHIKAN.



THE 25-K.W. CONDENSER AT KETCHIKAN STATION.

a mine owner in Juneau recently dispatched a message from there to Los Angeles, California, and received a reply 40 minutes after filing the original message at Juneau.

The construction of the foundations, etc., at Ketchikan was found to present no great difficulties, the sub-soil being from 18 to 36 inches deep, of a very soft character, and the underlying rock of a shaly composition and easily excavated by the constructional engineers. Four towers of the self-supporting type have been erected to support the aerials, the towers being placed at the corners of a rectangle 300 by 600 feet. The site is facing a strip of water known as the Tongass Narrows, the long axis being in the true direction of Astoria, Oregon. This is in order to obtain maximum radiation and reception. Each tower is 300 feet high, with a wooden topmast projecting 14 feet above the head of the steel. Upon these are mounted 80,000-volt triple petticoat insulators, carrying the antenna of two 7/18 silicon bronze wires, the tension of which can be adapted to meet any conditions of abnormal strains such as arise in high wind-storms and with sleet or ice. This antenna serves a double purpose, being used for

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A VIEW OF KETCHIKAN, ALASKA. THE ARROW INDICATES THE CLEARED RIGHT OF WAY OF THE NEW ENGLAND FISH COMPANY'S 3-PHASE 6,600-VOLT TRANSMISSION LINE TO GEORGES INLET, SIX MILES DISTANT.

transmitting for the marine service and for receiving with the 5- and 25-kw. sets. A 20-wire aerial is suspended on triatics between the towers and is brought down to the reinforced steel concrete power-house situated, roughly, 300 feet from the base of the lower two towers. Here it is connected to the 25-kw. transmitter. The power for the station is brought on a 2-mile transmission line at 2,200-volts, single phase, 60 cycle frequency, from the Ketchikan City Power-House. In order to obviate trouble by induction between the power-line and the aerial, the former is led through an underground conduit for some 300 feet before entering the station. Here it is connected to the high-tension switchboards and thence distributed to the various units—transmitting apparatus, lighting and heating transformers, etc. A synchronous rotary converter furnishes 70-volt direct current for operating the solenoid keys and side-disc motors and by means of an extension on the shaft drives a rotary discharger, which controls the number and duration of the spark discharges. This discharger is of the latest Marconi type, being of 30 inches in diameter and rotating at about 1,800 revolutions per minute. Close to its periphery are inserted brass studs equally spaced around the disc, which, in rotating, passes between the two side-discs set to give a clearance of 1/32nd of an inch. The discharge takes place across this small air-gap, namely, between the side-discs and each of the revolving studs in turn. As the discharger is rotated synchronously with the alternator, supplying energy to the condenser, which it discharges, it is necessary to time the discharge to occur at or near the peak of the voltage wave in the alternator. The correct point on the voltage curve depends on several factors, and arrangements are provided to permit adjustments being made between the time at which the revolving stud passes the side-discs and the time when the machine voltage is at its highest, in order to obtain maximum resonance effects.

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The condensers consist of glass and zinc plates placed in earthenware containers, filled with oil, a bank of 30 units being used in the circuit. Copper bus bars of ample dimensions lead from the condenser bank to the oscillation transformer and to the disc discharger, the coils of this transformer being wound with a special designed cable, and so arranged that each strand carries a similar amount of current and thus decreases heat losses.

The receiving office is 75 feet from the power-house and contains the operating key and the usual equipment, supplemented by two loose coupled receivers (fitted for crystal and valve detectors), having a range of 100 to 4,000 metres and 100 to 7,000 metres. A difficulty met with, even in the use of power as low as 25 kilowatts for radio telegraphic purposes, is that of controlling the current so that speedy manipulation is possible. For satisfactory service the operator must be able to handle the key as if it were controlling no more power than is usually required to operate a land line key—this means that every time the key is depressed power to the extent of 25 kilowatts will be allowed to flow into the wireless circuit and must cease as soon as he opens the key, and, moreover, the starting and stopping of this flow of energy must be instantaneous. This is accomplished by means of a solenoid key in the 22,000-volt leads, which is actuated by the operator's key, the solenoid key being provided with an air blast for blowing out arcs which might hold it inactive. Thus it will be seen that the operator can control the apparatus while far removed from the disturbing noise of the power-house.

The living quarters for the staff contain all modern conveniences, and are furnished in a liberal manner. The water supply is obtained from a 12,000-gallon reservoir, located on high ground to the rear of the station, being fed by springs whose source is in the near-by hills and virgin forests that surround the station. The latter added

THE TOWN OF JUNEAU, ALASKA. THE MASTS OF THE WIRELESS STATION CAN JUST BE DISCERNED ABOVE THE ARROW.

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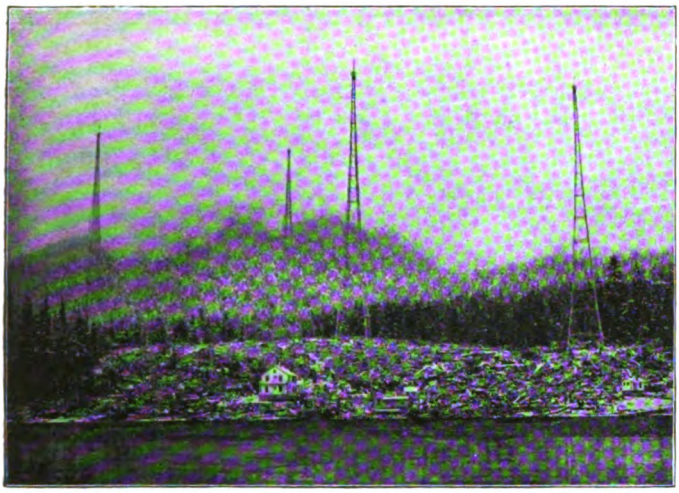

KETCHIKAN STATION. THESE MASTS, 300 FEET HIGH, DOMINATE THE SURROUNDING COUNTRY.

greatly to the difficulties of our construction engineers, coupled with the fact that the rainfall in that vicinity averages 168 inches yearly. However, this excessive rainfall is of great advantage to the ground system, which consists of 3,000 pounds of zinc plates buried in a circle around the power-house, supplementing which are 4-feet strips running out on to the beach to mean low-tide levels, thus insuring at all times a good electrical ground.

To the north 250 miles is the Juneau Station, which will be a counter plant of the one at Ketchikan, with the exception that it will have but two 300-foot towers. In the interim, the old station has been remodelled with a 10-kw. plant.

The wireless conditions in Alaska are peculiar, due possibly to the geographical form of Alaska and the continuous daylight during the summer months. It frequently happens that a vessel in these waters, although able to communicate in one direction for some 700 miles, is totally unable to exchange signals more than 20 miles in the opposite direction. Another peculiarity was noticed at the Astoria Station during the first few weeks of operation. The atmosphere would be quite clear of static till noon, so clear, in fact, that the impression was obtained that the aerial was disconnected or the receiver out of adjustment, but at noon static would appear and gradually increase until 1 p.m., when it reached a maximum, remaining so until 5 p.m. Thence until midnight atmospheric conditions were those usually prevailing at similar stations. This midday rise in the static curve appeared to be constant until the season had passed, as it suddenly did on August 28th.

THE DUPLEX DWELLING AT KETCHIKAN. THIS BUILDING CAN ALSO BE SEEN ON THE FORESHORE OF THE PHOTOGRAPH ABOVE.

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PERSONALITIES IN THE WIRELESS WORLD

PROFESSOR MAGNUS MACLEAN, M.A., D.Sc.

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PROFESSOR MAGNUS MACLEAN is a native of Skye, and is one of the foremost authorities in this country on natural science. He is an M.A. and D.Sc. of the University of Glasgow and a member both of the Institution of Civil Engineers and the Institution of Electrical Engineers. He is a Fellow of the Royal Society of Edinburgh and a member of several other learned institutions. His name will always be associated with that of the late Lord Kelvin, to whom he acted as Chief Official Assistant from 1884 to 1899, when his Lordship was Professor of Natural Philosophy in the University of Glasgow. Professor Maclean was associated with Lord Kelvin in all his experimental work during these fifteen years, which included the period when the standard electric balances were perfected. A large number of papers, notably on the Electrification of Air, were jointly contributed by Lord Kelvin and Professor Maclean to various meetings of the British Association as well as to the proceedings and transactions of the Royal Society.

In 1899, Dr. Maclean was appointed Professor of Electrical Engineering in the Royal Technical College, Glasgow. His department includes teaching in wireless telegraphy, and, according to the Calendar, there is a standard Marconi marine wireless telegraphy installation in the College of 1½ kilowatts, the aerial being 325 feet long, at an elevation of 116 feet. The course includes lectures on the different systems of radiotelegraphy, laboratory practice, and Morse signalling to qualify for the Postmaster-General's certificate in telegraphy. The Technical College of Glasgow stands first among similar institutions in the country, and owes much of its arrangement and scheme of administration to Professor Maclean's advice and supervision. Professor Magnus Maclean is the author of several scientific works, his greatest effort being "Modern Electric Practice," in six volumes. He secured the assistance of over thirty contributors for this work, each a specialist in his subject. The third issue is now passing through the press.

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The Special Problems of Aircraft Wireless—V

By H. M. DOWSETT, M I.E.E.

AIRCRAFT BALANCING CAPACITIES. AEROPLANES.

As no danger of fire accompanies the use of wireless on aeroplanes—the risk of ignition of petrol vapour by a spark being so small as to be practically negligible—there is no trouble in arranging an aeroplane balancing capacity ; every part of metal work in the frame, engine, stretcher wires, wing stays, etc., can be connected up for the purpose.

Wood is much used in the frames of British and French machines, but all German machines have frames made exclusively of steel or of one of the lighter tough alloys—see the illustration of the " Albatross " waterplane, Fig. 1.

But the sum total of capacity surface obtainable on the average machine is small, and this is only partly compensated for by the safe use of transmitting voltages which on a free balloon or dirigible might prove dangerous, as this does not help reception—*the* wireless problem of the aeroplane—which is still further handicapped by the noises of the motor and the wind. These noises interfere more with telephone reception on an aeroplane than on a dirigible, but they are quite distinct from signals and can be read through, if signals are moderately strong, by any capable operator.

Additional fixed wires are sometimes spanned to increase the capacity, but the extra resistance which is thus offered to the air is a strong reason why very little is done in this way, and then only where it is likely to have least effect on the flying efficiency of the machine.

The wide surfaces of the wings, for example, would seem to offer a natural support for a grid of wires, but when it is remembered that the successful constructor has learnt by experience that any seam, knot, or head of a nail projecting above the tightly stretched wing fabric, or any roughness of the surface due to bad varnishing has its effect on the behaviour of the machine, and that therefore " finish," in so far as it tends to give the wing surfaces their true geometrical shape, certainly pays, it is clear that there can be no question of fitting wires on the wing surfaces for radio purposes. Tinfoil pasted on and then varnished would be less objectionable, but it weathers badly and is really impracticable. However, if the wings could be employed as wire-supporting surfaces, the increase in capacity which would be obtained would prove very useful on biplanes, and much more so in proportion on monoplanes which have no cross bracing, only a few short wing stays in addition to the chassis to form a capacity.

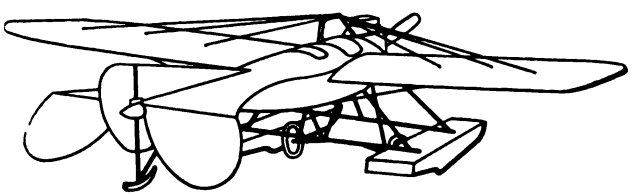

FIG. 1. THE "ALBATROSS " WATERPLANE.

The accurate calculation of the electrostatic capacity provided by an aeroplane

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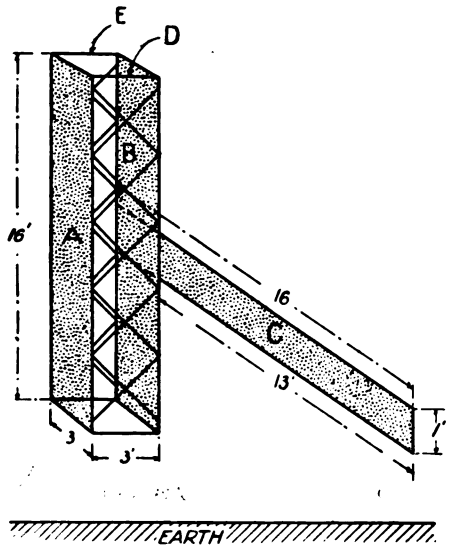

FIG. 2. AEROPLANE CAPACITY MODEL.

is not a simple matter. Fortunately in practice an approximation is all that is required. If the wings could be wired they would provide the greater part of the capacity, and the formulæ for wire grids could then be used. The wing stays in monoplanes and the stretcher wires in biplanes would only add 3 per cent. or 4 per cent. to the total. The wired or metal body or chassis may add from 15 per cent. to 30 per cent. depending mainly on its length, and whether it is open lattice or armoured, and the machine a biplane or a monoplane.

If the wings are not wired, the approximate capacity of a monoplane can be got by treating its chassis as an ellipsoid of revolution and allowing a certain extension to its length to correct for the wing stays; if a biplane, by assuming that each set of front and back stretcher wires can be replaced by two parallel wires the length of the wings and half their distance apart—a method of dealing with them similar to that suggested for the cross bracing of the Zeppelin frame—the chassis being " T'd " on to them.

Some tests were recently made which give useful values for estimating aeroplane capacities. A vertical wooden frame 16 ft. in length and 3 ft. square was covered on two of its opposite sides with sheet zinc, A and B, Fig. 2. Diagonal wires of No. 7/22 copper, crossing each other at right angles, were laced down the remaining two sides D and E, the ends of the frame being left open. A horizontal arm C, also covered with sheet zinc, was fixed to the middle of the frame, projecting from it 13 ft. as shown.

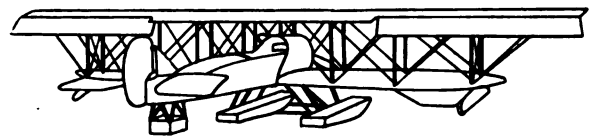

FIG. 3. THE " SHORT " SEAPLANE.

This model served to represent a biplane, the parallel sheets of zinc the metalised wings or wings fitted with wire grids of narrow spacing, the diagonal wires the wire bracing, and the arm the chassis, the relative dimensions being much the same as those met with in practice. Thus, the " aspect ratio "* would be 16/3 = 5.3, and the area of the arm, including that part which laps on the zinc of the vertical frame shown dotted in Fig. 2, representing the body of the machine, was equal to one-third that of one of the wing plates.

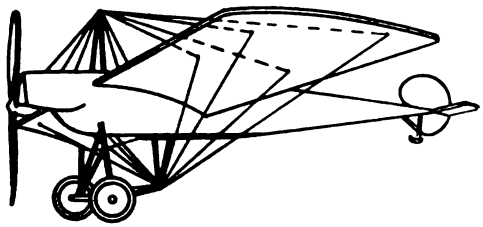

FIG. 4. THE " FOKKER " MONOPLANE.

* The " aspect ratio " is the ratio of the wing span to the chord of the wing curvature.

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The results obtained are tabulated below :

Arrangement of Model.	Equivalent to	Capacity.
		cms.
C, zinc sheet	Monoplane chassis only	126
C and B, zinc sheet	Monoplane chassis and wired wings ..	228
A and B, zinc sheet ; D and E, wired ..	Biplane, wired wings, and stretcher wires..	202
A and B and C, zinc sheet ; D and E, wired	Biplane, chassis, wired wings, and stretcher wires.	269
C, zinc sheet ; D and E, wired	Biplane, chassis, and stretcher wires ..	194
D and E, wired	Biplane, stretcher wires only	140

The above capacity values were measured by a high frequency method using series inductance. Mean height of model above the ground in open field, 9 ft. 9 ins. Tests were made to determine the influence on the capacity of the neighbourhood of the earth, but owing to bad weather conditions they were inconclusive. A mean correcting factor of 10 per cent. may be assumed.

Then, if the capacity of such a model is measured at a given mean height above the ground, the increase in capacity of a larger model having the same relative dimensions, will be directly proportional to the linear increase, provided the mean height is also increased in the same proportion. Thus, the wings of the average machine have a span which may be anything between 28 ft. and 46 ft. The chord of the cambered wing is seldom less than 5 ft. or more than 7 ft., and the overall length of the machine is between 24 ft. and 40 ft. A mean of these values gives a span of 35 ft., a chord of 6 ft., and a length of 32 ft. If these were the dimensions of a monoplane, the section through the body having one-third the wing area, and assuming the whole area of wings and body to be of sheet metal, the probable capacity in free space would be about 449 cms. Or, supposing the dimensions given above were those of a biplane, the planes being separated a distance of 6 ft., and stretcher wires as shown in Fig. 3, being fitted between them, then its probable capacity in free space would be about 530 cms. But if the wing surfaces could not be used, the capacity of the monoplane would be about 227 cms., and the biplane about 382 cms.

There are many small machines, however, any one of the many types of scout plane, for instance, which cannot approach these figures. The " Fokker " monoplane, a sketch of which is shown in Fig. 4, is a case in point, and this is larger than the French standard " Moraine-Saulnier " although of the same type. The minimum dimensions of such planes would be about 20 ft. span, 5 ft. depth of wing, and 17 ft. over all length, from which one may estimate that the capacity obtainable using the wings would be about 257 cms., and without the wings 120 cms.

At the other extreme there are the large battleplanes, the Russian "Sikorski" biplane being one well-known example, the French triplane with a span of 70 ft. is another, and there are several biplanes now in use in the French service which have a span of 130 ft. A triplane is said to be under construction in the United States having a span of 133 ft. and a length overall of 68 ft. This information

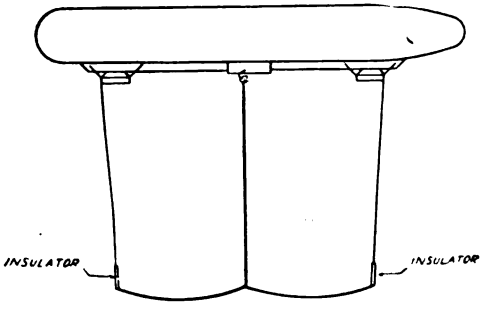

FIG. 5.

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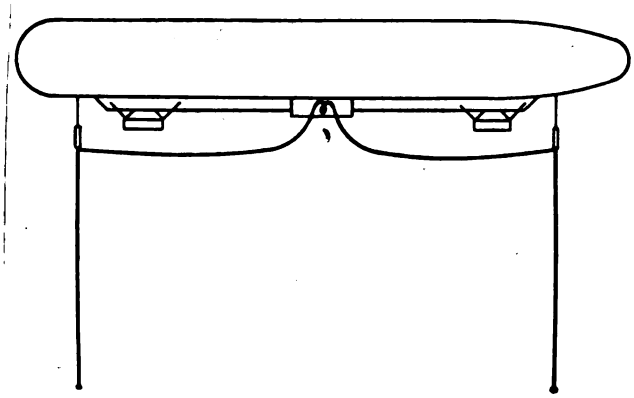

FIG. 6.

is not complete enough for us to obtain an idea of the capacity which could be obtained from such a machine. However, as this aeroplane will be the largest of its type, its probable capacity can be regarded as a limiting value, and it is for this reason useful to know. We shall, therefore, assume values for the dimensions we do not know which need not be very far out from the true values. Then, let the two main planes be of equal length, 133 ft., the length of the lowest plane being less, say 93 ft.; the "aspect ratio" to be 10 for the upper planes and 7 for the lowest plane. The depth of each wing will then be 13·3 ft., and we can assume the distance between the planes to have the same value. Such aspect ratios are high, but experimentally a still higher ratio 13 : 1 has been used with success,* and it would seem probable that high ratios must be used with these very large machines.

An aeroplane of the above dimensions could provide a balancing capacity in free space of about 1,090 cms. without using the wings, and with the wings about 1,510 cms. This last value, it may be noted, is of the same order as that obtainable on an airship of medium size.

* * * * * *

Special Forms of Aircraft Aerial Circuits.

The Zeppelin aerial occasionally takes the form shown in Fig. 5, known as an "anchor" aerial. It does not extend so far into space as an equivalent single wire, and thus interferes less with the navigation of the vessel.

For reasons of symmetry and spread, it enters the central compartment of the airship which in times of peace is fitted as a passenger coach, and in times of war as a ballast, bomb, and general stores.

Another aerial system which is directional in character, strongest signals being received from it in the plane of the hanging wires, is shown in Fig. 6. This also connects to the wireless apparatus in the middle compartment of the airship. Although not directly connected with the metal frame enclosing the gas bags, the open form of this radiating system must result in considerable inductive effect upon it, which should necessitate special care in the preliminary

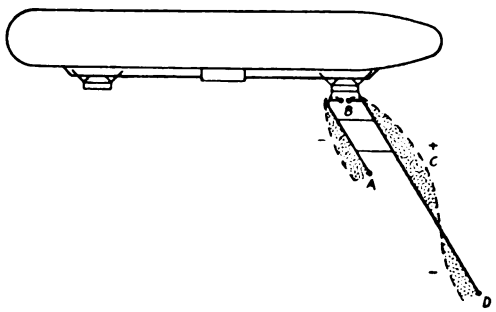

FIG. 7.

* F. W. Lanchester, *Aerodynamics*, 1911.

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tests to make sure that the induced potentials for the transmitting waves used are not dangerous.

The " Shutte-Lanz," having a skeleton constructed mainly of wood, runs far less risk from induction, but as metal work in the form of angle iron, iron plate and wire bracing, is used, though sparingly, where reinforcement is necessary, inductive effects do exist and must be allowed for.

As one cannot safely tune up the directional aerial system so as to be in resonance with the Zeppelin skeleton, better results might be expected if this large independent capacity were not present. For this reason a " Shutte-Lanz " installed with the above arrangement should work more satisfactorily than a Zeppelin.

The next method to be illustrated, Fig. 7, shows a form of Lecher wire circuit suspended under a gondola, consisting of two aerials mechanically tied together, one of them being three times the length of the other (Beggerow). If they are both excited to the fundamental frequency of the shorter wire as shown, the part ABC will act like the H.F. primary circuit of a coupled transmitter, and the part BCD as the radiating secondary, most of the radiation taking place from CD. Under such conditions only weak inductive effects are to be expected, as all live parts, especially the most active part of the aerial, are well separated from the actual body of the balloon.

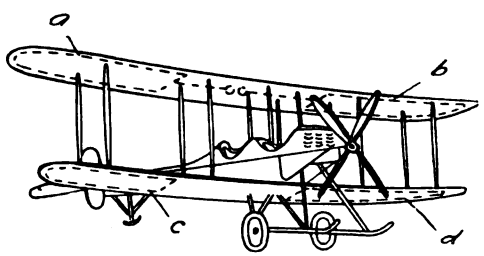

FIG. 8.

In order to increase the small capacity available in the frame and bracing of the aeroplane, additional wires symmetrically suspended from the wings have been tried (Backer), but the method has proved of little value.

In place of a single trailing wire, a double trailing wire has sometimes been used. A two-wire aerial is shorter than a single wire for the same free space capacity, and its increased spread in relation to the balancing capacity on the aeroplane will increase the total capacity of the radiating circuit a small amount. Against this has to be set the difficulty of manœuvring two wires, and the fact that the spacing between them cannot be made more than 3 or 4 ft. at the outside.

A further arrangement, devised to overcome the difficulties associated with a trailing aerial, is roughly indicated in Fig. 8 A and B are two metallic surfaces fixed on the top wing of an aeroplane and suitably insulated from each other, which, together with a spark gap, form a type of Hertz oscillator. The spark gap could, of course, be replaced by the jigger winding of a coupled circuit. On the lower wing are two other capacity surfaces which can be brought into use for directive transmission. The two upper plates A and B would then be connected together, and the charge would oscillate between them and the two lower plates C and D (Fessenden). This method also has failed to prove of much use in practice.

(To be continued.)

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Digest of Wireless Literature.

The Static-Coupled Receiving Tuner.

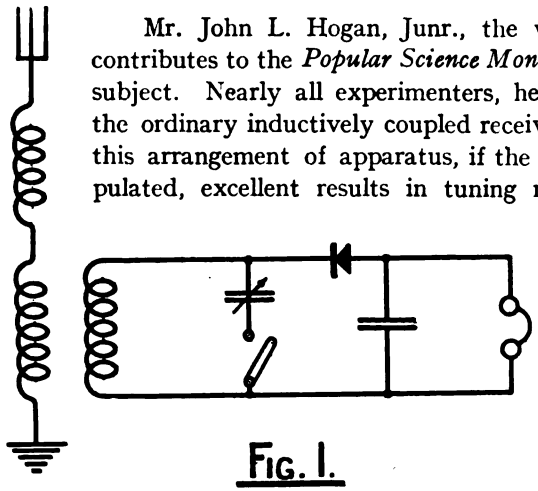

Fig. 1.

Mr. John L. Hogan, Junr., the well-known American wireless expert, contributes to the *Popular Science Monthly* an interesting article on the above subject. Nearly all experimenters, he says, are familiar with the action of the ordinary inductively coupled receiving tuner, illustrated in Fig. 1. With this arrangement of apparatus, if the elements are well designed and manipulated, excellent results in tuning may be secured. There are, however, certain difficulties in constructing such a tuner, and unless the work is well done there is a loss in efficiency. A somewhat different type of tuner, which is now coming into rather extensive use, usually gives sharp tuning and loud signals, yet is very easily assembled. The connections are shown in Fig. 2, and may be seen on examination to bear some resemblance to the inductively coupled tuner of Fig. 1.

In Fig. 2, however, the primary and secondary are set far apart, so that there is practically no magnetic coupling between them. A third condenser, C3, which is preferably variable and of small minimum capacity (say from 0.00005 to 0.001 microfarad range) is put in circuit, as shown. This additional condenser governs the coupling of the system; when C3 has small values the coupling is loose and the tuning sharp, and when C3 is increased the opposite condition is approached. The two coils need not be moved at all in order to secure any of the desired coupling effects; therefore, either primary or secondary, or both, may be cariometers and the end-switch losses thereby eliminated.

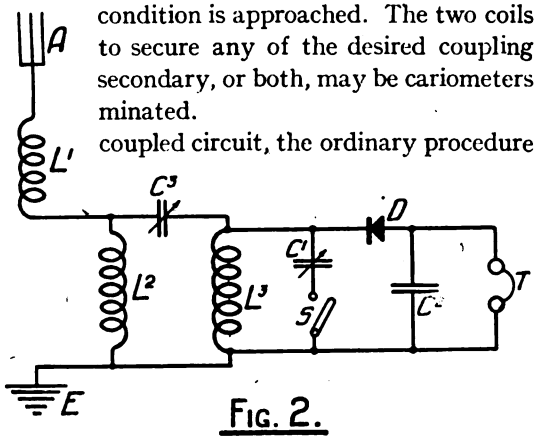

Fig. 2.

In tuning with the condenser coupled circuit, the ordinary procedure is followed. The coupling is made close and, with the secondary condenser disconnected by opening switch S, the primary is adjusted until the desired station is heard with the greatest loudness. The switch, S, is then closed, and the secondary system tuned by varying L3 and C1. If interference is present, or if the incoming signals are very sharply tuned, the best results are secured by gradually loosening the coupling and at the same time adjusting L2 and C1 to keep the signals at maximum strength.

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A High-Power Plant for Research Work.

The *Wireless Age*, for February, contains an account of the high-power wireless station which has been recently installed and placed in operation at Tufts' College,

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Medford, Mass. A noteworthy feature of the station is the skeleton steel mast, 304 feet in height, imbedded in solid concrete. It is only 3 feet 6 inches square at the base, and can be seen for miles.

Supported on four specially designed porcelain insulators, which rest on fifteen tons of reinforced concrete, it is constructed of 12-feet sections of structural steel, and is held in position by twelve heavy crucible steel guy wires, 1 inch in diameter, secured at different heights and fastened at the lower ends to blocks of concrete. The tower is topped by a large antenna from which ten fine wires conduct the electric current to the laboratory below.

The Tufts' station is 96 feet above the sea level, and near the bottom of a hill, but high enough to overcome local obstructions of the waves, such as houses and trees. At the same time it receives the drainage of the hill, and for this reason the soil is damp all the year round—an excellent condition for the earth connection.

The interior of the laboratory building is finished in smooth white stucco, trimmed with dark green lattice work. The building is practically sound and vibration proof, allowing the use of the most delicate instruments, a very important factor of the research work now being carried on. Each room was tested with a microphone. A large assortment of the latest testing meters is to be found in the laboratory. The floors are all ouble and lined with heavy layers of felt. The doors also are double and sound proof. The Tufts' Wireless Society will have a room in the building, and eventually the plant will revert to the Tufts' College.

The equipment of the machine shop is so complete that it is possible to turn out practically anything from a watch spring to an automobile engine. All the machinery is of recent design and is equipped with modern safety appliances.

Mr. Harold J. Power, manager of the Atlantic Radio and Research Corporation, which established the plant, has a specially designed laboratory for his own use. Mr. Power has had considerable experience as a Marconi operator and first went to sea as wireless man on the Metropolitan line.

* * * * * *

CONTINUOUS WAVE TRANSMISSION AND RECEPTION.

Some interesting comments on the progress of radiotelegraphy were recently made by Mr. John L. Hogan, Junr., in the *Electrical World*. Writing of continuous waves, he says, that in considering their success it is most interesting to note that the reasons first advanced in their favour have not been entirely sustained by experience. While their use does permit of somewhat sharper tuning at receivers, by the use of looser couplings, this is not so marked an advantage as was claimed in some quarters. Neither has there been found the great decrease in absorption alleged in the arc-versus-spark controversy of some years ago. The unquestioned point of superiority lies in the effect produced *at the receiver*, when this is of the electrical beats or heterodyne type. To understand this condition it must be appreciated that the greatest remaining problem of the radio engineer is the elimination or reduction of atmospheric interference from "strays," and that, of all so far proposed, the method of probably the greatest proved value depends upon securing a musical signal tone which the receiving operator can easily distinguish from the irregular noises of atmospherics. One other method is of perhaps equal value. It consists in the use of a receiver which responds more strongly

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to feebly damped energy than to abrupt and highly decadent impulses such as those from strays. A high degree of such persistence selection is secured in the beats receiver, and, combined with a useful amplification, this is had whether the apparatus is used with grouped-wave or sustained-wave transmitters. When continuous waves are received, however, the phase relation of incoming energy remains such that the heterodyne produces signals of a pure musical character. In addition, the maximum of persistence selection is attained, and thus, since static disturbances are more nearly eliminated than in any other combination now used, the benefits secured from undamped waves become incontestable.

The use of heterodyne receivers has been vastly extended during the past year by the gradually spreading realisation that three-element vacuum tubes may be used as radio frequency relays, and therefore (on the humming telephone principle) as oscillation generators as well as detectors. The surprising delicacy of these receivers is well known, and the simultaneous use of a single bulb as rectifier, amplifier, and oscillator, has already produced almost startling results in long distance signalling under favourable conditions. In apparatus so employed the signals are produced by the conjoint effects of incoming and locally generated radio frequency currents, and, as in any other heterodyne, musical signal tones are created. As would be expected, the great sensitiveness of the device makes its use subject to interruption by strays, which would not affect seriously less delicate and consequently more reliable instruments. When atmospherics are at a minimum, however, vast distances may be covered by virtue of the great signal amplification obtained. It has recently been reported that Nauen, Germany, has been heard at Honolulu, Hawaii, a distance of 9,000 miles.

If success rewards the efforts to find an entirely new way to minimise the harmful effects of static interference, it will become possible to make practical use of the great magnifying properties of the relays already available. This will result in great saving of transmitter power consumption for long-distance radio communication, since at present the sending installations must be made many times more powerful than need be for communication in the absence of static.

* * * * * *

A Plea for the Unification of Telegraph Engineering.

Colonel G. O. Squier, during a recent discussion at the Institution of Electrical Engineers on Mr. H. H. Harrison's paper, "The Principles of Modern Printing Telegraphy," made an eloquent plea for the unification of Telegraph Engineering. "In thinking over something pertinent which might be said on this subject," remarked Colonel Squier, "and in view of the unusual number of telegraph experts present this evening, it has occurred to me that it would be best, in an effort to contribute perhaps something constructive, to call attention to the desirability at the present time of a careful stock-taking of the whole of telegraphy, from beginning to end, to see where we stand in the matter, and perchance to profit by certain tendencies now developing. In the newest branch of telegraphy, the so-called wireless telegraphy, we find that during the past 16 years, due to the way in which the subject has appealed to the imagination of all classes, some of the best-trained minds of each country, as well as a large number of practical engineers and a host of amateurs, have been attracted to assist in the solution of the manifold problems presented. This has resulted in the accumulation

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of a vast storehouse of engineering and physical data traceable directly or indirectly to this new and fascinating field. In this phenomenal development we see a good example of the wisdom of borrowing freely from other arts whatever is necessary for our purposes. The radio engineer has taken from the power engineer his low-frequency dynamos, power transformers, etc.; from the older art of wire telegraphy, keys, sounders, buzzers, Morse printers, choke coils, etc.; from the pure physicist, some of the most refined of his laboratory efforts, and now he threatens to appropriate Mr. Orling's long-cable jet relay, and Mr. Heurtley's cable magnifier. In addition, he has completely broken down the barriers between telegraphy and telephony, since in his hands each radio telegraph circuit becomes a telephone circuit by merely substituting the microphone for the telegraph key. I do not criticise this procedure, I commend it to members' serious attention. We find, in fact, that the re-borrowing process has already begun, and in the case of the recent inauguration of the New York-San Francisco telephone line, one of the principal factors in final success was due to an instrument originally developed as a receiver for radio telegraphy and telephony. It would appear that the word 'wireless' is an unfortunate one from an engineering standpoint. The radio engineer is strictly limited in all its efforts to the propagation of alternating currents either within, upon, or along metallic wires, and none of his skill can change in the slightest degree the character of the ethereal part of the circuit between the antennæ. The moment the energy breaks away from wires he has lost all control until, or unless, it again comes in contact with other wires. On this view, therefore, radio engineering appears merely as an extension of the much older art of wire telegraphy, and there is no such thing as wireless telegraphy. A radio station may exhibit within itself the whole range of phenomena from an alternating current of low frequency propagated by conduction through metal, as is the case in the primary generator circuit, up to this same energy transformed into an alternating current flowing along the wires of the antenna at a frequency which makes the radiation factor, instead of the conduction factor, the predominant one. It seems possible that some day we may be able to have a perfectly general telegraph equation which will contain sufficient terms to apply to any case from pure radio transmission, through wire practice, down to ocean cable telegraphy, by substituting the proper value of n, the frequency. In such an equation, of course, the radiation terms would entirely disappear for low values of n, and would reappear gradually as n is increased, until we come to the case of pure radio transmission. If we glance, for a moment, at the other end of the engineer's scale of possible frequencies, we go below the normal range of power frequencies—viz., 50 or 60 per second—and enter a region as yet wholly undeveloped. In this region falls the whole of the present ocean-cable practice. The strange thing about a 2,000-mile ocean cable constructed with practically no leakance or inductance is, that we arrive at a state of affairs very similar to the wireless case with antennæ, although the phenomenon is one of conduction and not radiation. In other words, it appears that in such a case we may consider short portions of the cable at the ends as a sort of 'submarine conduction antennæ,' which we design and use to launch the power on to its path across the ocean; and, on this view, the real ocean cable, which should be practically uniform throughout, begins 100 miles or so from shore at each end, and the end pieces should be considered more as a part of the station equipment than as part of the real ocean cable. These end pieces we can load with inductance and adjust to a maximum reading of a hot-wire

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ammeter exactly as we do with the radio antennæ. Furthermore, upon examining the essential transmitting circuits we find them an exact duplicate of the radio transmitting circuits, with the exception that the inductances and capacities required are microfarads and henries, instead of thousandths of a microfarad and millihenries. We see also that the amount of power we can put into this kind of antenna is directly proportional to the square of the voltage used, and therefore one of the first moves to be made for real progress is to design the end pieces to take much higher voltages—say, from 100 to 500 volts at least—and then so distribute the copper and gutta-percha in the deep-sea portion of the cable as to produce minimum line loss in attenuation of the waves. As to the intermediate cases between ocean cables and pure radio telegraphy, which would include the whole of land-line telegraphy and telephony on pole lines, here we have the phenomena of conduction, reflection, and radiation in varying relations depending upon the value of the frequency employed. In land-line telegraph practice, however, we find that after over half a century the signals are still sent by making and breaking a battery current. At each break the line is charged with a large number of idle harmonics which upset the line apparatus generally, and as no single frequency is used in sending the signals themselves, we are barred from utilizing the principles of electrical and mechanical tuning and of automatic magnification which have done such great things for the radio engineer. Since we can scarcely hope to realise in telegraph practice Heaviside's 'distortionless circuit,' we can employ a 'distortionless harmonic current' which, in the steady state, is propagated by any form of circuit with zero percentage change of shape and maximum efficiency of power transmission. As we pass immediately above ordinary telephonic frequencies on wires we find a region of guided electric waves which are more or less linked with the conductor. It is not unreasonable to suppose that the telegraph engineer will in the future pay as much attention to the outside surface of his wires as he now does to the composition of the wires themselves. These surfaces may serve him to appropriate and control certain closely bounded regions of the free ether of space to create for him new channels of communication by guided electric waves. Our knowledge of skin effect should be extended by researches into the region bordering upon pure radiation, where we are dealing with a super-skin effect or film effect, and it seems not unlikely that we may be able ultimately to dip the wire or paint it with a metallic paint rich in unstable atoms or free electrons, which will tend to reduce the attenuation of the guided waves. Here the efforts of the master physicists should furnish a sure guide in the near future. These guided high-frequency channels are in some respects superior to any wire circuit. For telephony we may have in them a perfectly silent line, and one with no distortion whatever. The attenuation is greater, but it is not attenuation which limits wire telephony at present, but a mixture of line noises with distortion. With these new channels the telephone repeater comes into its own, since there is nothing to repeat but pure articulation and quality. The telephone receiver itself may be of the radio type, 10 or 15 times more sensitive than those possible to use in wire telephony. In printing telegraphy these channels should also be useful, as they can operate relays. They are free from many fluctuations of pure radio circuits, such as day and night differences, etc., and in a twisted-pair become very reliable indeed. The new ionized-gas form of generator now furnishes a convenient high-frequency source in single or multiple units. The power required is negligible when compared with the case of free waves in three dimensions. The object

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of these remarks, therefore, is to offer a plea for a more general survey of telegraphy by engineers and physicists at this stage of rapid progress. At present we find the separation and segregation of the field of telegraphy into certain more or less watertight compartments under the head of wireless telegraphy, land-line telegraphy, ocean-cable telegraphy, etc., each of these possessing a separate technique. For instance, the radio engineer prefers to think in wave-lengths, and he calls a variable inductance a 'variometer' and a certain tuning coil a 'jigger,' etc., whereas, of course, there is nothing new in principle in these pieces of apparatus. The wire engineer prefers to think in terms of 'frequency,' and plots his graphs with n as a principal variable. The cable engineer thinks in terms of 'curves of arrival.' Has not the time arrived for the standing telegraph committees, wireless committees, cable committees, etc., of our scientific societies to combine in a membership that can look at this whole subject as one subject, which in fact it appears to be ? "

Wireless World Problem Competition Result.

WE have great pleasure in announcing that the PRIZE OF ONE GUINEA for the best problem in the competition announced in our January number has been awarded to C. E. Woodward, B.Sc., of 10 Chesnut Road, Westdale Lane, Gelding, Notts.

We take this opportunity of thanking all of our readers who have submitted problems, and regret that we have been unable to reply to them individually.

Mr. Woodward's problem is as follows : " A condenser (capacity 12 milli-mfds) is made up of 12 smaller condensers (in parallel) of four different sizes—viz., 4, 2, ·5 and ·25 milli-mfds respectively. How many of each size are there ?

This is a little problem for the mathematician and others who have benefited from our instructional article. The solution will appear in the May number.

A number of other interesting problems which have been sent into this competition will be published in future numbers, and in each case the answers will be given in the issue following that in which the problem is printed.

In the case of the previous problems which we have published, a very large number of readers have sent in their answers, the reply being in most cases quite correct. Whilst we greatly appreciate the enthusiasm thus demonstrated, we would point out that in present conditions we are totally unable to respond individually, and we trust that those of our correspondents who have not received replies will understand that this does not arise from any neglect or lack of appreciation on our part.

A consolation prize of 5s. is awarded to Electrician H. Christie, of H.M.S. *Bonaventure*, for the following most amusing problem : " If 5 gallons of petrol supply 7 " Marconi field sets for 14 days, and 7 Marconi field sets send 60 messages in 3 days, " and 4 messages get 3 loads of provisions in 28 days, and 2 loads of provisions feed " 4 sappers of Royal Engineers for 6 days, and 3 sappers of Royal Engineers burn " 21 searchlights in 2 days, and 2 searchlights find 3 Germans in 1 day. How many " Germans will 2 gallons of petrol find in a week ? "

The answer to this problem will also be published in our May number.

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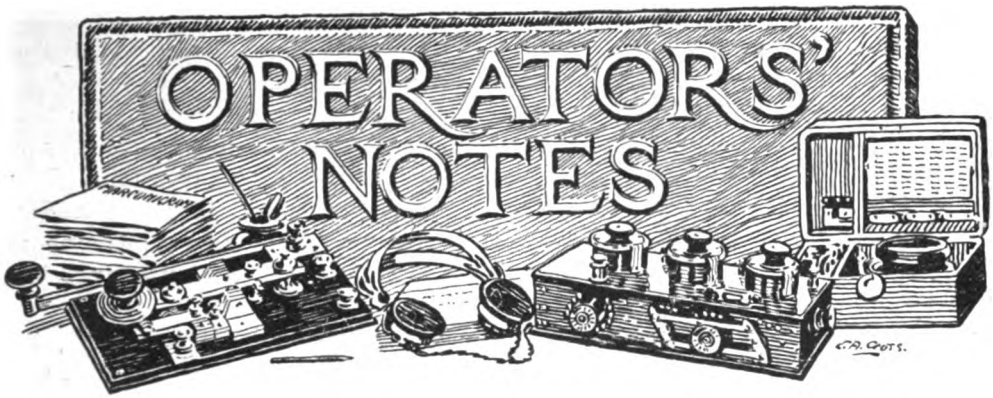

THE conscientious wireless operator, when taking charge of an installation, naturally desires to keep all of the apparatus under his care thoroughly clean and in the best order; and if it is in a bad state through lying up or other causes his efforts should immediately be directed to its restoration to proper condition. A few hints on this subject may therefore be useful to the new man.

The materials which the operator is required to keep clean are chiefly wood, brass, platinum, slate and ebonite. It is essential that all woodwork should be kept perfectly dry, and care must be taken that no varnish is removed. Dry varnished wood has fairly good insulating properties for low-tension work, but wet woodwork is a frequent source of serious loss. In many ships the operating table is fitted immediately beneath the porthole, and unless care is taken in wet and boisterous weather to screw up the port tightly there may be a continued leakage of water on to the instruments. In the silence chamber a leaky Bradfield tube gland may permit entrance of water and cause injury to the transformer and condenser. At frequent intervals the operator should inspect this section of the apparatus, removing all dust and dirt and any sign of dampness, for a pool of water on the lid of the condenser or transformer may allow the moisture to creep inside these instruments, and in this way there will be not only leakage on the outer cover but also faulty insulation in the interior.

Speaking of the silence chamber, we may mention that in many cases "sparking-over" between the busbars has originated through moisture finding its way to the ebonite, and for this reason frequent inspection of the connections is necessary. A casual glance and quick rubbing with a duster are useless; every part must be carefully wiped. Another frequent cause of trouble is coal dust, and the operator who leaves his silence chamber open while the ship is coaling may have his communication interrupted at a vital moment by violent sparking between terminals and busbar, due to the coating of coal dust thereon.

Practically all of the brass work of a wireless installation when sent out from the works is coated with a good lacquer which prevents tarnishing and corrosion. Every endeavour must be made to preserve this lacquer, as once it is removed no end of trouble will be found in cleaning. Metal polish should be avoided in all cases except when the lacquer has been removed and the metal is in a very dirty condition, for this substance removes all the lacquer at practically the first rub. If all lacquered brasswork is dusted daily and all traces of moisture removed with a dry cloth no trouble whatever will be experienced, but in cases where the metal has been neglected an oily rag will often remove the dirt with the greatest of ease.

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Special care, however, must be given to contact surfaces of switches, and nothing greasy or oily must touch these or imperfect contact will result. Dirty switch faces and studs should be cleaned when necessary with fine emery, care being taken that the metal dust is all removed from the adjacent insulating material so as to prevent leakage or short-circuits. The slate faces of switchboards should be rubbed daily with a dry cloth and will then always present a good appearance. In cases of neglect the dirt may be removed with an oily rag, but in such cases every trace of oil or grease should be removed from the slate immediately afterwards and the surface polished with a dry cloth.

Ebonite is a material very easy to keep in good condition if frequently attended to, but very liable to deterioration if neglected. It cannot be dusted too often, and if rubbed frequently with a dry cloth will retain its appearance and polish almost indefinitely. All moisture, and especially sea water, is harmful to its surface, and oil or grease is most injurious. Many men in charge of installations have endeavoured to improve the appearance of their tuners by wiping them over with a greasy cloth, the high polish thus temporarily obtained being very pleasing, but it will be found that after a day or two this gloss disappears and the fine surface of the ebonite has gone for good. Experience has shown that the only safe treatment is rubbing with a dry cloth, and no one should be misled by seemingly good effects obtained by other means. It is always an advantage to keep the tuners screened from the direct rays of sunlight, particularly in tropical regions, as strong light seems to have a harmful effect on the substance.

Whilst in every part of the installation careful attention well repays the operator by the good results obtained, this is nowhere more evident than in the case of the platinum key contacts. Dirty contacts cause excessive sparking, arcing, and sometimes fusing. In some cases we have known as much as a sixteenth of an inch of platinum has had to be filed away in order to restore the smooth surface—a wastage of extremely valuable material due to nothing but carelessness on the part of the operator. If these contacts are periodically cleaned and smoothed with fine emery a single pair may be made to last for considerably more than a year, even on the busiest transatlantic ships, whereas if they are neglected they may only last a couple of weeks on a steamer with practically no traffic.

Key contacts may be kept perfectly clean by passing a piece of fine emery paper once or twice between them every few days, care being taken that the surfaces are kept plane and not rounded. When arcing or sticking has taken place, however, the key lever should be removed and the contacts smoothed with a piece of fine emery stretched flat on a piece of wood. A file should be used only in extreme cases, and then with greatest care and accuracy. It is useless endeavouring to file contacts by opening up the break and passing the file between them, for, if this is done, the two pieces of platinum will not come together flat when the keys are depressed, but at an angle.

Some further notes on the maintenance of apparatus will be given in our next issue.

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Dr. Zenneck's Book on Radiotelegraphy*

Reviewed by W. H. ECCLES, D.Sc.

In undertaking the review of a new technical work the reviewer who wishes to be fair must endeavour to put himself in the author's place, must try to understand the author's motives and aims, and must visualise the class of reader the author caters for. Then he must find how far the author's purpose is fulfilled. This is a lengthy process, which involves the weighing of each section and the balancing of the whole, and should lead to the formation and expression of a correct opinion as to whether or not the book was worth writing, and whether the task is well or ill performed. Not all this effort is required in the case of a translation, however. In fact, the matter is virtually decided in favour of the author long before the translation is decided upon.

But another and not less important duty of the reviewer is to convey to his own readers as vivid an impression as he can of the scope and depth of the book, of its accuracy and trustworthiness, of its clearness and compendiousness, of its novel points and up-to-dateness, of its typography and finish. On many of these matters a pronouncement may be made at once from a recollection of the work in its original tongue. As regards scope, we may say that it extends over the physics of wireless telegraphy rather than over its practice. As regards depth, this is very variable; there are places quite profound and others very shallow—which may be intentional, and not, as one is tempted to think, a matter of accident. Of the accuracy and trustworthiness of the volume as a whole we may say at once that in scientific affairs it appears to the present writer as standing on the highest plane—it is only on minutiæ (in scientific matters) that he can find faults. The style is usually clear—for which the translator deserves very great commendation—and only occasionally diffuse, and in typography and finish the book is all that can be desired and is a credit to its publishers. Unfortunately one cannot call it up to date—there is no sufficient account of beat-reception, of the tone-wheel, of frequency changers, or of the modern Poulsen arc plant. There must always be some time-lag in the translation of a technical book, so, leaving this out of account, we may praise the volume in the aggregate as the best work of an accomplished scholar, who has spared no pains in the way of consulting original papers in order to get and give a comprehensive view of the scientific aspects of his subject. On the other hand, the engineering aspects of wireless telegraphy are not very adequately treated; and one may fairly say, also, that the attention paid to laboratory researches is overwhelmingly greater than that paid to the records of the patent offices.

A brief analysis of the contents of the book will prove the best way of calling attention to its merits.

The first chapter deals with discharge and oscillations from the theoretical and experimental point of view. The feature worthy of note is the careful account of the physics of the electric discharge as regards its effects on the decrement of oscillations. Chapter II. passes to the consideration of waves, and resembles many other books in subject matter and manner of exposition. Much of the information conveyed is very vague, being merely qualitative where it might easily be quantitative. Chapter III.

* *Wireless Telegraphy*. By J. Zenneck. Translated from the German by A. E. Seelig. McGraw-Hill Book Co. 17s.

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deals with apparatus and with some simple high-frequency measurements and contains some excellent pictures of condensers and the like. Chapter IV. is devoted to Coupled Circuits. It cannot be said that these two chapters introduce anything new into English literature, and some of the matter included is ancient and, in many eyes, discredited. But the next chapter, on Resonance Curves, goes more thoroughly into the physical theory and the laboratory measurement of decrement than any other single work one can recall. Still, one must not forgive such misleading errors as the identification of "sharpness of the peak of the resonance curve" with "radius of curvature," on page 105. Chapter VI., on Antennæ, is good, but not deep, and is more academic than practical. The discussion of the effect of coils and condensers on the wave-length of an antenna is, however, so feeble as to be useless.

The more practical portion of the book begins with Chapter VII., which deals with "Transmitters of Damped Oscillations." Here it is necessary to pause and comment upon the remarkable (and, may we say, nonsensical?) classification of "transmitters" invented by the author and used throughout the remainder of the book. Put briefly the classification is into: (*a*) The "*Marconi transmitter*," in which a spark gap is inserted in the antenna and the latter is charged by means of an induction coil; (*b*, 1) the "*Braun transmitter*," in which the antenna is coupled to a condenser circuit and two oscillations are produced; (*b*, 2) the "*Wien transmitter*," like the last, but with a quenched spark gap and a single oscillation. The effect of this ingenious subdivision is that all the defects (by the way, no virtues are mentioned) of primitive plain aerial sending become associated with the name of Marconi. All the benefits of coupled circuits which Braun did not discover become associated with the name of Braun, and all the advantages of the Telefunken system (pictured in this book in rosy colours) become credited by inference to Wien, though very few indeed owe their inception in any degree to any of Wien's excellent investigations of the phenomena of quenching. The creation of prejudice by means of the innuendo of nomenclature is an unworthy device in a standard treatise and cannot be passed over without protest. Protest becomes, perhaps, the more necessary because, in describing the scientific work of the numerous investigators named in the book, our author maintains a tone of scrupulously fair acknowledgment. In this chapter, it may be noted, the introduction of the A.C. resonance transformer for excitation of a spark gap appears to be credited as solely due to the Telefunken Co.; most English people believe it to be a characteristic French method. Apart from such flaws as just indicated, this chapter is an admirable one and views things from a standpoint not quite the same as that adopted in English text-books, and is, therefore, instructive.

The next chapter, on High-Frequency Machines, is very slight, and Chapter IX. proceeds to describe Arc Methods of generation of oscillations. The discussion of the Poulsen arc theory is informative and clear, but the final page, on the distinction between "spark" and "arc," might as well not have been written—no one will be wiser, we think, after reading it.

Chapter X. deals with the propagation of waves over the earth's surface. None of the matter in this chapter carries us past 1911 or 1912, and all of it already appears in extant text-books. Chapter XI., on Detectors, is not very deep or very practical, though very correct. Chapter XII., on Receivers, is rather diffuse and not at all modern. For instance, the gas relay and the beat method of reception by aid of three-electrode tubes are not touched upon. Chapter XIII., on Directive Telegraphy, contains

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a careful and full discussion. It is noticeable that the author states here, rather dogmatically, that an L antenna, though very directive on land, is not at all directive over sea water—a deduction from a particular theory which, so far as the writer is aware, has not received the slightest experimental corroboration. Chapter XIV. contains six pages on wireless telephony and some very brief notes on the development of wireless telegraphy during the years 1909 to 1912, intended, apparently, to bring the original German edition more up to date. Then follow some Tables for use in the laboratory. The book is closed by a very useful bibliography and a full index.

In this analysis the datum plane that has been borne in mind is that afforded by extant English text-books, British and American; for one of the chief questions occurring to anyone on seeing a translation of a book that may be called a standard work in its own country is: Is it likely to attain among English-speaking peoples a reputation commensurate with that it holds at home? and, Was it worth translating? As a broad rule, translations of technical works never do attain in the new language the vogue and authority they possess in the original tongue. One reason for this is that they do not accord so perfectly with the national spirit and ideals of the new field of readers as with those of the people they were written for. Another and perhaps more important reason for the non-attainment of an important position in a new tongue is that there may exist already a number of books covering separately or together much the same area. This, one is inclined to think, is to some extent the case with Zenneck; there is already at the disposal of English readers a library that gives nearly, though not quite, all that is to be found in Zenneck. The original German work was designed to fill a vacant space in German technical literature, and, being early on the ground, it was written round by later German authors; there is no such vacuum in English technical literature, and this present translation inevitably overlaps existing treatises conspicuously and at numerous points.

One may close this review by attempting to answer the query: What class of reader was the book written for? It is easier to say what class is not aimed at. The treatise is certainly not intended for beginners in electrical matters, nor for those who want to construct apparatus and learn telegraphy, nor is it intended for engineers erecting stations. Perhaps it is best suited for the type of advanced student who wishes to become familiar with the physical research aspects of wireless telegraphy. To such men the book should prove very valuable.

Share Market Report

LONDON, *March 15th*, 1916.

THERE is nothing of interest to report in the Share Market, except that the demand for wireless shares has somewhat fallen off. Marconi (Ordinary), £1 18s. 9d.; Marconi (Preference), £1 13s. 9d.; Marconi International Marine, £1 5s.; American, 15s.; Canadian, 6s. 3d.; Spanish and General Wireless Trust, 5s.

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Our readers will notice that, with the new volume, we are starting to present this section to them in a slightly different form. We have to thank our friends for many kindly expressions of appreciation in the past, and hope that our present rearrangement—whereby the longer notes are classified under our main heading and the shorter remarks relegated to war notes—will meet with their approval. Our illustrations are being contributed by Mr. J. W. Nicolson.

A German Professor and the Unpleasant Truth.

In our issue of August, 1915, in an article entitled "Germany: Transatlantic Wireless Schemes," we referred to the fact that for the effectiveness of her colonial development and for the safety of her colonies Germany had relied upon a chain of wireless stations, which was almost, if not entirely, complete before the outbreak of war.

In our issue of October, 1915, we again recurred to this subject, and printed the opinion admirably expressed by Mr. Godfrey Isaacs, in his speech to the Wireless Company's shareholders, that the completeness of this chain had given good proof of its power by snatching from the jaws of the British Navy the prey which would otherwise have been inevitably seized. Not only did the German chain thus fully justify our enemies' outlay upon it, but it has repaid its capital expenditure many times over.

Moreover, we have, on page 450 of the above-mentioned issue, indicated to our readers that ample justification for the importance attached by both groups of combatants in the present world-struggle to this chain of German wireless installations is established by the fact that the various stations have successively formed the objective of Entente attack. So amply is it demonstrated that these wireless stations and their *locale* form the vital point of the enemy organisation, that their capture has in every instance proved to be the deciding factor in the campaign.

The lessons that we have been formulating in our various previous issues, and referred to above, constitute the main theme of an interesting lecture delivered by Privy Councillor and Professor Dr. Hans Meyer in his recent address delivered before the German Imperial Institute of Oceanography.

The learned Professor discoursed upon the fate of the German colonies, and a candour usually absent from Teutonic speakers prevented his saying anything very cheerful on the subject to his distinguished audience.

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He made the "sad admission" that the German Colonial Empire was in a parlous state owing to the action of the enemy, and under existing circumstances regretted his inability to suggest any way out of the difficulty, save the "acquisition of a satis- "factory base for the German Fleet in Europe." The learned Professor did not, however, state whether he considered this base should be located in the Mediterranean, in the Adriatic, or on the Atlantic Coast.

Professor Meyer, after comparing, greatly to the discredit of the British (*"Gott Strafe England"!*), the methods adopted by the various Entente Allies in their colonial conquests, denounced the "short-sightedness of those who erected *wireless stations "within range of the cannon of British ships,"* and wondered why mistakes of this character had not been attended to before the outbreak of war.

* * * * * *

WIRELESS WAR TRAPS.

In connection with the bogus wireless appeals which often constitute a source of danger to British and Allied merchantmen we would remind our readers of an incident in the Mediterranean Sea which occurred to the liner *America* whilst on her way to Naples from New York. Soon after she had left Gibraltar her commander received a wireless message which instructed him to change his course and steer to a certain rendezvous where he would be joined by an escort. The message in question purported to have come from Algiers and to have for its object the preservation of the *America* from the danger of encountering an enemy submarine. The wireless operator, however, had his suspicions that all was not as it seemed. Perhaps he knew the peculiar note which is, or was, characteristic of the Algiers Station, and doubted the source of the message in consequence. Anyhow, he seems to have reported his suspicions to the captain that the message appeared to emanate from a point very much closer to the vessel than the origin claimed for it. Acting on the hint, the *America* carefully avoided steering the course recommended by this faked message, and eventually reached Naples in safety. This kind of trick on the part of German submarine commanders must have been resorted to in many cases of which we have no knowledge, because, if the ruse be successful, its victims do not survive to tell the tale.

"UNDER TWO FLAGS"; THE GERMAN SUBMARINE COMMANDER SHOWS HIS TRUE COLOURS.

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GERMAN "JAM" AND GREEK "PRESERVE."

WE have recently been treated to a most lurid story of how the famous German cruiser *Goeben* and her consort escaped the clutches of the Allied Fleet. The story, "made in Germany," is most precisely and dramatically told in the pages of Emil Ludwig, a teutonic author of some repute, who claims to have heard the facts first hand in Constantinople. The narrative runs as follows :—

When the *Goeben* arrived at Messina (Sicily) where, as Italy was then neutral, she was allowed 24 hours' grace for coaling ; the question arose—in which direction would the German vessel steam next ? According to their own account the Germans intended from the beginning to shape their course for the Dardanelles ; and hearing that *H.M.S. Gloucester* was wirelessing information calculated to lead the British Admiral to believe the German objective to be the Adriatic, the Deutscher artfully "permitted" the message to pass, and carefully refrained from interfering with so useful an enemy ! All this is in the best style of the super-artful detective, characteristic of Adelphi melodrama in its palmiest days. What followed is worth quoting in the words of the German text :—

"It was dark as pitch. The *Breslau* closed in. From the bridge ran the order—"'right about' ; 'starboard' ; 'make for Cape Matapan.'"

TWO MORTAL HOURS OF UNMITIGATED GERMAN . . . WIRELESS . . . STRAFING.

The watching British cruiser observed the manœuvre, but had no opportunity for reporting it ; for the heroic Teuton bellowed the staccato orders: "jam the British 'wireless, jam it like the devil !"

Of course the victorious waves of *Telefunken* won an easy victory. "Wireless wave broke in upon wireless wave ; sound interrupted sound ; for two solid hours."

Think of it, readers, *two solid hours of unmitigated German wireless strafing!* Enough to shatter the whole High Fleet of Admiral Jellicoe, if it had been within range !

Such is the marvellous history marvellously told, with full circumstantial details. But is it true ? Well ! the story is German. . . . We will say no more

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In the land of Homer, however, men are not to be outdone when a good subject for Heroic Legend is floating around. They also have *their* version, only in their case the hero is a Greek instead of a German Admiral. Although not so melodramatic as the German, the Hellenic tale is much more subtle.

In August, 1914, when the two German cruisers were in the port of Messina and the Allied Fleet waiting for them outside, Mons. Venezelos, the villain of the piece, was Prime Minister. He, with his characteristically Anglophil leanings gave instructions to Admiral Condouriotis, in command of a Greek Squadron, to assist the Anglo-French Fleet in drawing a wireless cordon round the German warships. The gallant Nauarchos was not to engage in battle, but to keep watch, and advise Mons. Venezelos by wireless of their movements. The latter would then pass on the information to the British Fleet. Our noble Greek saw the German vessels pass, but instead of despatching his wireless to the false Venezelos, despatched it to the loyal Tino, brother-in-law of the All Highest. *The latter put it in his pocket and kept it there!* Of course, when the truth came out, Mons. Venezelos dismissed the naval hero of Greece from his command; but in the meantime the German cruisers had safely made their way to the Golden Horn.

TINO . . . . PUT THE "WIRELESS" IN HIS POCKET—AND KEPT IT THERE!

Thus we have two accounts of the same occurrence, and we must leave it to our readers to determine whether they swallow the German "jam" or Greek "preserve." It has been whispered to us, not however by wireless, that there is yet a third version which does not tally with either of the stories told above. This version is British and . . must await until the end of the war.

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The Ubiquitous Amateur.

In the various countries which form the great Entente League against the common enemy of humanity wireless amateurs for a long time past have had perforce to stay their hands. Very different conditions hold good in the United States of America; here wireless amateurism has been passing through a period of such rapid development

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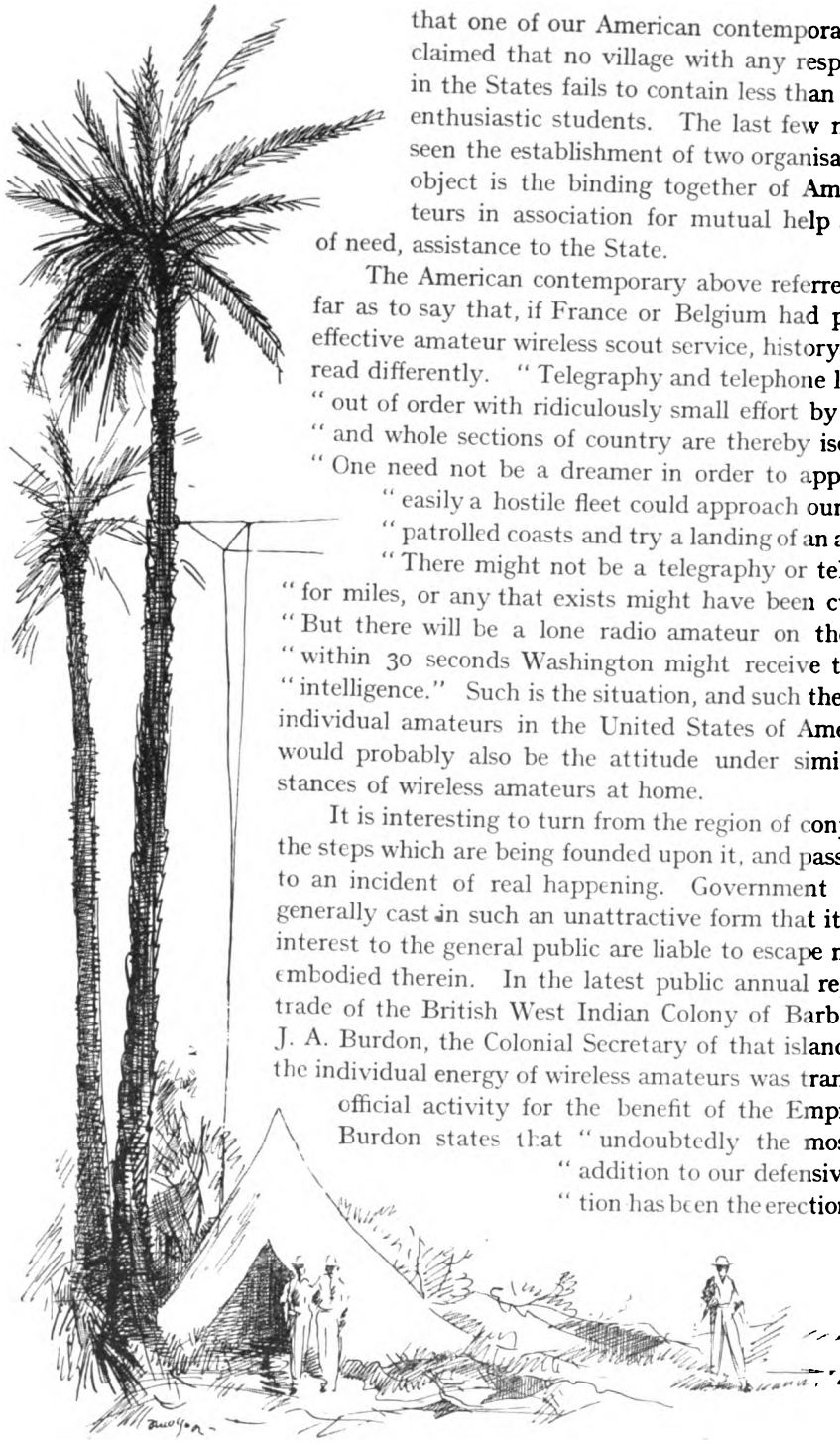

A BARBADOS WIRELESS CLUB.

that one of our American contemporaries recently claimed that no village with any respect for itself in the States fails to contain less than two or three enthusiastic students. The last few months have seen the establishment of two organisations, whose object is the binding together of American amateurs in association for mutual help and, in case of need, assistance to the State.

The American contemporary above referred to goes so far as to say that, if France or Belgium had possessed an effective amateur wireless scout service, history might have read differently. "Telegraphy and telephone lines are put "out of order with ridiculously small effort by the enemy, "and whole sections of country are thereby isolated. . . . "One need not be a dreamer in order to appreciate how "easily a hostile fleet could approach our long, badly "patrolled coasts and try a landing of an armed force. "There might not be a telegraphy or telephone line "for miles, or any that exists might have been cut by spies. "But there will be a lone radio amateur on the alert, and "within 30 seconds Washington might receive the priceless "intelligence." Such is the situation, and such the attitude of individual amateurs in the United States of America; such would probably also be the attitude under similar circumstances of wireless amateurs at home.

It is interesting to turn from the region of conjecture, and the steps which are being founded upon it, and pass there from to an incident of real happening. Government reports are generally cast in such an unattractive form that items of real interest to the general public are liable to escape notice when embodied therein. In the latest public annual report of the trade of the British West Indian Colony of Barbados Major J. A. Burdon, the Colonial Secretary of that island, tells how the individual energy of wireless amateurs was translated into official activity for the benefit of the Empire. Major Burdon states that "undoubtedly the most valuable "addition to our defensive organisa- "tion has been the erection by certain

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" members of the Volunteer Force of a very efficient wireless station for military purposes, " which has placed the colony in permanent wireless communication with Trinidad, " and has, therefore, relieved it from the dangerous position of sole reliance on the " submarine cable for reporting an attack or appealing for assistance."

The history of this installation dates from the establishment some time prior to the outbreak of war of a Barbados " Wireless Club." Its youthful members learned the practice of radiotelegraphy by talking to each other on little home-made installations erected on bamboo poles or palm trees. Their membership roll includes individuals attached to the local Volunteer Force. On the outbreak of war these volunteers offered to erect an installation if they received some financial assistance. This was given, and an " Umbrella " aerial capable of work over a fifteen-mile radius was soon being operated night and day by an unpaid volunteer staff. After a week's existence, a 10-inch induction coil, borrowed from the hospital, increased the transmitting range to 40 miles, and this range was still further extended to 60 miles by a generous gift from a British steamer. The installation continued to grow, power from the Electric Supply Corporation was brought in, which, aided by home-made improvements to the apparatus, give the installation a radius of 150 miles. The final step was taken when a lattice mast was lent by the Corporation, whose manager is himself a volunteer, and the " Umbrella " installation was converted into an " Inverted L " aerial, whilst the transmitting range was increased to 220 miles. The island is thus placed in touch with Trinidad and any British warship within range.

Even before the enemy vessels had been cleared from these seas no attempt was made to attack Barbados ; the approved organisation for defence was kept mobilised, and sundry false alarms showed them to be fully prepared for any attack. The whole situation is particularly interesting to those who happen, like the present writer, to be well acquainted with the genial inhabitants of " Bimshire," as it is locally called, and reminds one of the common saying amongst 'Badian " gentlemen of colour " which dates back to the time of the Napoleonic wars, and runs, " King George 'im nebber fear so long " as 'Badian 'tand 'tiff."

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Science and Romance in the South Seas.

It is not often given to a peace-loving scientist and his wife to come across a romantic adventure of violated neutrality and " secret wireless." Yet such was the lot of Mr. W. S. Routledge, M.A. (Oxon), and his wife, Mrs. Katherine Routledge, M.A. (Dublin), who were commissioned by the British Museum to visit the South Sea on an important archæological expedition. The *Mana* was the vessel specially designed for this scientific voyage by Mr. Charles Nicholson, of Gosport, and our two travellers were as loud of praise at the end of their journey as at the beginning. After a three years' voyage the vessel arrived at the beginning of this year at San Francisco, and on her arrival bore positive proof to America that the German Fleet operating in the Pacific Ocean had repeatedly and flagrantly violated the neutrality of Chili, coaling from captured vessels in Chilian ports, besides having landed at Easter Island and erected a large signalling station there for observation purposes and the despatch of wireless messages. Mr. Routledge's story is that on the arrival of the *Scharnhorst*, flying the flag of Admiral von Spee, he knew nothing of the European war until they learned from the stories

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A TYPICAL EASTER ISLAND LANDSCAPE.

spread by the Germans that "Australia and New Zealand were republics, and King "George had been deposed and a republic formed in Britain."

The German fleet and its prize vessels remained at Easter Island six days. This fact, in itself, constituted a violation of Chilian neutrality, treated with the usual Teutonic nonchalance. Mr. Routledge then proceeded to the mainland, leaving his wife behind, there to learn, for the first time, the real truth of affairs, and illness detained him on the continent for over two months. During his absence, Mrs. Routledge witnessed the arrival of the *Prinz Eitel Friedrich*, with a French collier prize, from which the German cruiser proceeded to coal. Whilst committing this further neutrality violation, "the Germans," says Mrs. Routledge, "sent a detachment of armed men ashore under "an officer and *erected a large signalling and wireless station*, to give news to the Com-"mander of the *Prinz Eitel Friedrich* should any British ships put in an appearance."

Easter Island formed an excellent base for them: there was meat in abundance, good opportunities for keeping watch, and generally smooth water for coaling in Cook's Bay.

The narrowest escape of the *Mana* occurred about the middle of March, when she was returning from Chili with Mr. Routledge on board. The German cruiser *Dresden* was at that time prowling around in the neighbourhood, but fortunately happened to be too busy coaling for future depredations, and the *Mana* managed to escape her. We understand that Mr. and Mrs. Routledge will, under the auspices of the British Museum, publish the result of their researches, after their return to England, early in March.

WIRELESS WORLD readers will understand from the story of this base of supplies and radiotelegraphic station, nefariously established on an island belonging to a neutral Power, located on a coast where visits of ships occur only at very long intervals, how it came to pass that the German commerce destroyers for so long preyed upon British shipping without incurring the consequences which ultimately overtook them.

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War Notes.

RANDOM JOTTINGS ON "WIRELESS" BY LAND AND SEA.

Commonsense about Montenegro.

An exceedingly interesting article under the title of "Commonsense about Montenegro" appeared in *Land and Water* of February 3rd from the pen of Mr. Alfred Stead. Incidentally this account of Montenegrin activity (or inactivity) in the course of the war indicates the difficulties of Italy, and forms an eloquent testimony to the extent to which public opinion in this country has done our Trans-alpine ally injustice. "The Italian wireless station on Lovken," says Mr. Stead, "which reported the movements of the Austrian "vessels in the Bocche, had its telephone wire to Cettinje cut several times a week, "and notably when any vessels were leaving the harbour. All movements of trans- "ports arriving for Montenegro were known immediately in Cattaro with obvious "results."

The fact of the matter appears to be that, very naturally, in the light of modern history, to the Montenegrins Austria was *the* great empire. Ignorant of the sea, England was to them largely a name, the value of sea-power an unknown quantity. They openly averred, despite the Italian marriage, that Italy was of small account compared with Austria. "The truth was not in them," is the way in which Mr. Stead sums up the general attitude of the Montenegrin Government. They were obsessed with the desire for the possession of Skutari, and there can be little doubt that the Austrians came nearer scoring the complete diplomatic victory which they prematurely announced than many members of the British public are inclined to realise.

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"Owls and Mice."

Recently von Tirpitz conducted what he doubtless looks upon as an extremely daring incursion into the North Sea. How he and his bold rovers must have been delighted at the chance of relieving the monotony of skulking in safety at Kiel! Assuredly the excursion was conducted with much trepidation, although when to their great relief they got back again there was much puffing out of Teutonic chests and much boasting of Teutonic tongues as to how they had "scoured the North Sea for the "enemy, but had nowhere been able to sight the British Fleet."

Information has come in since, from neutral sources, which tends to show how exceedingly cautiously the operation was conducted. Captains of Danish merchantmen who observed the manœuvrings of the Teutonic battle squadron state that it clung with great tenacity to coastal waters. Overhead Zeppelins and aeroplanes kept an anxious look-out for signs of danger, and *wireless messages* passed from these aerial watchers to the ships, advising them when it was safe to proceed a few miles farther. Thus, in fear and trembling, under wireless guard, von Tirpitz's men advanced, and in fear and trembling they retired. The aircraft sentinels were uninterruptedly in wireless communication with the German Fleet, and were alone responsible for the successful German exposition of the children's game of "Owls and mice."

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A Curious Misunderstanding.

A great deal of misunderstanding with regard to the nature of German official accounts of the doings of their army appears still to exist amongst the British Press. One of the British Weekly Reviews recently quoted from the Hamburg *Nachrichten* to the effect that: "The Zeppelins came out of the "night and taught the haughty English people that the war can overtake "them everywhere, and that it is bloody, terrible, and serious. England's "industry to a considerable extent lies in ruins. England's own soil has "been ploughed up by the mighty explosive shells of German air squadrons." Our contemporary draws the legitimate inference that the German people gloat over this kind of "swinish inhumanity."

But the Review in question proceeds to inquire: "*Is it true that the report to "Berlin of this raid was transmitted from Norwich by wireless in English, not in German, "as usual?*" The question thus asked clearly points to a misunderstanding of a news item sent out by the "Wireless Press." This consisted of an account sent by wireless from the Norddeich Station, near Berlin, in English, addressed to the German Embassy, New York, for dissemination amongst the American Press. This "story" consisted of a fanciful narration of the dropping of incendiary bombs by Zeppelins, in the course of their latest raid, "on and near Liverpool and Birkenhead Docks, the harbours and "the factories. Also upon Manchester and on blast furnaces at Nottingham and "Sheffield, besides on a number of industrial establishments on the Humber and near "Great Yarmouth." The bombastically incorrect account given above, this German (Norddeich) version transmitted in English for the benefit of the United States, concludes with the direct lying statement (heedless of Zeppelin L19 and her fate) that all the airships "returned in safety." Wireless communication is the only direct means available for Germans when telegraphing to the United States, and the fact that they went to the trouble of communicating in English indicates their anxiety to impress our neutral cousins. The German message is interesting in itself, and was sent out to the newspapers, with a note on the circumstances surrounding it, by the "Wireless "Press." Our contemporary, evidently mistaking *Norddeich* for *Norwich*, appears to have jumped to the conclusion that the message referred to was an account traitorously transmitted to Germany from our charming little cathedral city in Norfolk.

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The Vital Point.

An echo of the activity of enemy submarines in the Mediterranean at the end of last year comes to hand in a letter sent by Trooper F. Flatters, who was a passenger on the transport *Mercian*, attacked by gunfire during that period. The German submarine followed their usual precedent of honouring *the wireless room* with their first attentions. Their gunnery appears to have been good, for, according to our Lincolnshire Yeoman, the second shell smashed to splinters the wireless cabin. The submarine's shelling continued for the space of an hour and forty minutes, at the end of which period it disappeared from its position astern and came up broadside, with the intention of torpedoing. The captain of the ship, however, swung the vessel round stern off, so that she did not get a chance and eventually was obliged to relinquish her expected prey. It was on this vessel that Lord Kesteven had the thick part of his leg blown away, dying the following day in a French hospital at Oran, in Algeria.

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Ether Waves among the Palms

Chatham Island and it's wireless

SINCE first the British Merchant Venturers sent out their ships in search of treasure in the southern seas, the South Sea Islands have exerted a curious fascination over the boyhood of England—and, for that matter, over most of the men. So great has been this influence that the words " South Sea Islands " whenever they appear conjure up in our minds visions of palms, yellow sands, coral and dazzling blue sea, and a picture of adventure and excitement with cannibals fierce and wary. It is hard to realise that wireless telegraphy, which itself is now surrounded by romance, has planted itself among these gorgeous islands, and removed them from the isolation on which depended so many interesting stories. Wireless masts now tower above the palms and jungles of many of these islands, enabling the peaceful inhabitants to sell their produce in a vastly wider market than has hitherto been possible, and now in wartime these stations have played a most important part.

The Chatham Islands, really three islands and some rocky islets, situated roughly 360 miles east of New Zealand, have now been connected to the mainland by a well-equipped radio station of considerable range. The operators in these sunny climes live a life which is, of course, very different from that of their *confrères* in this country and on the seas. We recently had the opportunity of perusing a long letter from one of these gentlemen, in which he gave many interesting particulars of his experience. There is an absence of worry in these parts very refreshing to read of for those of us who remain close to the seat of the war. Although the Germans were " cleaned out " of the Pacific some considerable time ago, due to the vigilance and activity of the Australian Fleet, it is yet necessary to keep a very strict watch at the wireless on the chance that something important may occur. Owing to the veil of secrecy which covers practically everything in the world of wireless, we are unable to describe much that would be of interest to our readers, but without doubt many thrilling stories from this part of the world will come to light after the war.

Speaking of the conditions in that part of the world, the writer of the letter says that the New Zealand Government has under its control four stations, three in New Zealand, and the one, of which we are speaking, in the Chatham Islands. The station

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at Apia (Samoa), of considerable power, has also an interest for New Zealanders, for it was taken from the Germans at the commencement of the war by an expeditionary force which left New Zealand under escort of the British warships *Psyche* and *Cambrian* and the Australian Navy's *Sydney* and *Australia*. Shortly before the expeditionary force arrived at Apia the German warships *Scharnhorst* and *Gneisenau* were lying in the port, but hearing that the British forces were on the way they cleared out and showed a clean pair of heels. Very little resistance was offered to the landing, and our troops remained at Samoa until the German Fleet had been swept from the waters of the Pacific. It is interesting to know that some of the German population remain there yet, including the staff of the wireless station. As the writer says: "Twelve months have gone by and these poor lightning-jerkers are still groaning under military rule, mosquitoes and intense tropical sun." The station is said to be an exceptionally powerful one, and we believe works very satisfactorily.

The Chatham Islands are under the jurisdiction of the New Zealand Government, the chief occupation being sheep-farming. In recent years the fishing industry has been developed, and is now thriving. There is but one steamer trading between New Zealand and the islands, this boat—the *Hemitangei*—giving a two-monthly service during most of the year. In the summer season trips are made rather more frequently. The Chathams fish, mostly blue cod, hapuka and trumpeter, are shipped first to Wellington, from which port the greater portion goes to Sydney, where blue cod always commands a good price. Sheep-farming, however, is the main occupation, and is said to pay far better than anything else could possibly do.

"The freight," says our correspondent, "is extremely heavy between here and New Zealand, and although the distance is only 536 miles the freight is £2 17s. 6d. per ton for general cargo, 5s. a head for sheep, and £3 a head for cattle and horses.

WAITANGI, THE CHIEF PLACE OF HABITATION. THE WIRELESS STATION IS FIVE MINUTES' WALK FROM HERE. "WAI" MEANS "WATER," AND "TANGI" "WEEPING." WAITANGI THEREFORE MEANS "WEEPING WATER."

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A FLOCK OF SHEEP IN THE CHATHAM ISLANDS. SHEEP-FARMING IS THE CHIEF OCCUPATION OF THE INHABITANTS.

This is what is killing the Chatham Islands, for whilst the freight remains so exorbitant the islands can never progress to any great extent. Fares are also very high. The *Hemitangei* is only a six hundred tons steamer, and accommodation is not of the best ; there are no stewardesses, and only one steward. The old tub rocks like a cradle, yet the fare to New Zealand is £4 single, and £6 return. I came down here in fifty-six hours—a record trip in its way—and ate nothing from the moment I left port until I landed here."

The Chatham Islands have a remarkable history, but unfortunately the men who could tell all the most interesting facts are dead, and it is to be greatly regretted that no records seem to have been kept. Long ago the islands were inhabited by the Morioris, and when the first Europeans landed they found them to be people of small stature and low intellect. They had no houses, and in order to protect themselves from the elements burrowed into the ground to a depth of several feet, and then wove sticks to form an overhead cover. The Maoris, inhabitants of the adjacent country of New Zealand, soon made their appearance, and set to work to exterminate the Morioris. Even now it is a common sight to see skulls and bones lying on the beach. The Morioris, being an inferior tribe in physique, were able to offer little resistance, and were killed on the slightest pretext. It is said that it was a common practice of the Maoris to stand half a dozen of their enemy in a line and fell a giant tree upon them. Skeletons have even been found in the hollow trunks of trees, where the persecuted aborigines probably crawled to avoid their foe.

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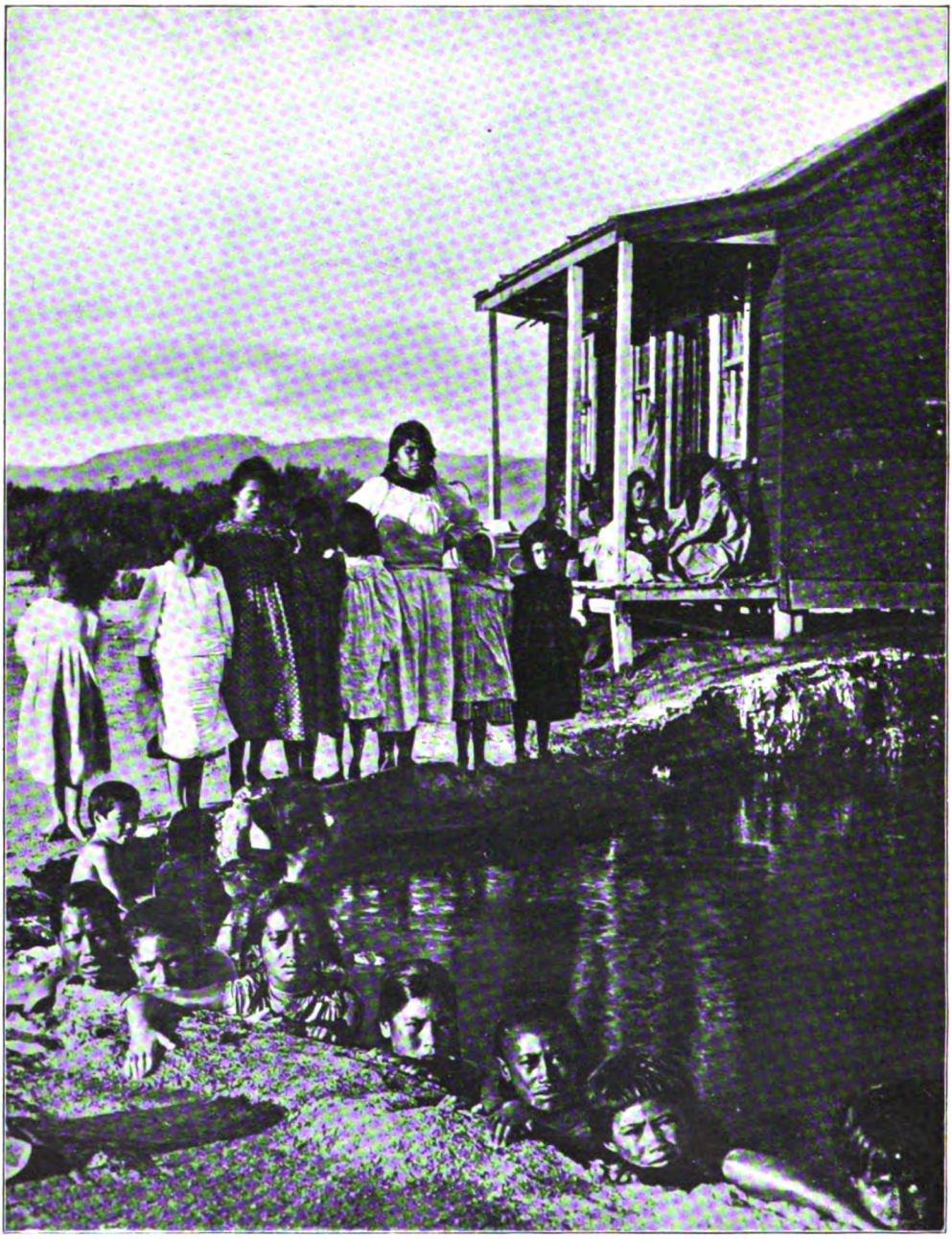

MAORI CHILDREN IN NATURE'S BATHTUB—A HOT SPRING WHERE WATER NEVER FAILS.

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The Chatham Islands were discovered in 1791 by Lieutenant Broughton, of the brig *Chatham*, from which they take their name. Some of the first Europeans to land were the whalers, and several of the men who remained are now well established sheep farmers of the islands. "One of the most remarkable things that I have noticed," the writer says, "is the fact that the majority of the male population have travelled all over the world before settling here. This says a great deal for the islands. It is hard to understand what they see in the place, and yet I must admit that I will have very sincere regrets when my time comes to leave. Everything is so peaceful, and there is no cause for worry, and practically no sickness. Everybody is in the pink of condition, and no one dies young. Money is seldom handled, and Money is seldom required. The best beef and mutton is delivered to your house at 3d. per lb., good hacks can be purchased at anything from £3 to £10 a-piece, and horse races are held annually." Dances are frequent during both summer and winter, and it is interesting to hear that Europeans and Maoris mingle together; and, to give the latter their due, they are excellent dancers. They behave themselves exceedingly well, and one loses nothing by being friendly with them.

MORIORI SKULLS AND BONES ON CHATHAM ISLAND BEACH. THESE GRUESOME RELICS ARE TO BE FOUND IN LARGE NUMBERS.

A large brackish lake occupies the interior of Chatham Island, which is of a volcanic nature and hilly. These lakes provide excellent shooting. Swans are found in vast numbers, and are everywhere. Ducks are not quite so plentiful, nevertheless there are a goodly number. Timber of any size is unknown, and the native canoe is merely wicker work bound together by cordage of indigenous plants.

The final paragraph of the letter is of particular interest to us, and shows how widely this magazine circulates. Closing his interesting account, our correspondent says: "Regarding THE WIRELESS "WORLD, you speak as though we have never heard of it in these parts. It may "interest you to know that our walls are adorned with a few of the best Buettler's "cartoons, and we also get a copy of the *Wireless Year-Book*."

THE WIRELESS WORLD cartoons on the walls of the operating room of a wireless station in the South Sea Islands! We are afraid that with modern inventions at our disposal the fascinating isolation of these spicy isles is gradually passing into the realm of the unknown!

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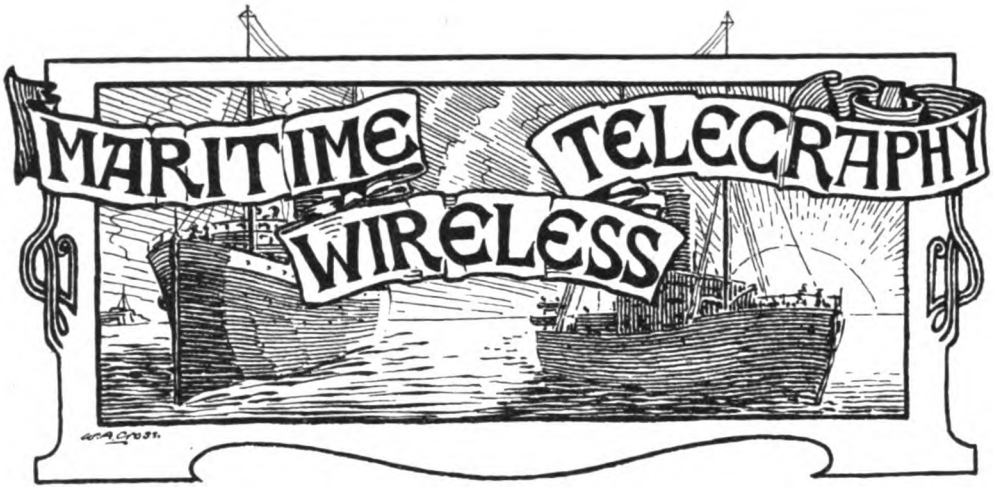

The "Volturno" Disaster.

An echo of the *Volturno* disaster is sounded by the announcement in the *Court Circular* that the King has decorated with the Board of Trade Silver Medal for Gallantry in Saving Life at Sea the following men :—

John Souter, fifth engineer, and William Brown, seaman, of the steamship *Devonian*, of Liverpool ; Joseph Kendal, seaman, of the steamship *Minneapolis*, of Belfast ; and Archibald Stewart, seaman, of the steamship *Rappahannock*, of Liverpool.

On the 9th of October, 1913, while the steamer *Volturno*, of London, was in the North Atlantic Ocean a fire broke out in the forward part of the ship.

Every effort to subdue the fire proved unavailing, and in answer to wireless messages for assistance 11 vessels proceeded to the help of the *Volturno*, including the British steamships *Devonian*, *Minneapolis*, and *Rappahannock*.

Great difficulty was experienced in communicating with the *Volturno* owing to the heavy sea, but finally 520 persons in all (457 passengers and 63 crew) were rescued ; 134 persons lost their lives.

Very considerable risk was incurred in rendering the services on account of the strong gale and very heavy seas prevailing at the time.

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The Loss of the S.S. "Maloja."

Once again we have to record the loss of a great Peninsular and Oriental liner, the *Maloja*. The *Maloja* was the largest vessel of the P. and O. fleet, and is the fifth lost by the Company since the outbreak of war, the others being *Persia*, *China*, *India*, and *Socotra*. It was on February 27th that the 12,000 tons liner struck a mine between Dover and Folkestone, the afterpart of the vessel being blown up by the explosion. There was a high sea running at the time, and the captain, seeing the extensive damage which the ship had sustained, tried to beach her, but he was unsuccessful, the engine-room being full of water owing to the damage. The vessel sank in about half an hour.

The *Maloja* was only two miles off Dover when the explosion occurred, and, says a *Daily Chronicle* correspondent, the final scenes were witnessed by a large number of

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people, who anxiously watched the progress of the rescue while the drama of the sinking great ocean steamer was taking place at so short a distance from them. The SOS calls from the great ship immediately brought to her rescue a large number of vessels and everything possible was done to save life. The vessel sank so rapidly, however, that many lives were lost. Some of the liner's boats were able to get away filled with people, and these were taken in tow by tugs and some pinnaces and brought to shore. A large number of the passengers and crew were also picked up in the water. Just after the *Maloja* had sunk those watching the scene from the shore had another thrilling experience. A second steamer, which proved to be the *Empress of Fort William*, laden with coal for Dunkirk, was lost in an exactly similar manner within half an hour of the liner. She settled down by the stern, but her forepart remained above the water some little time. The vessel then suddenly blew up and she disappeared in a cloud of steam.

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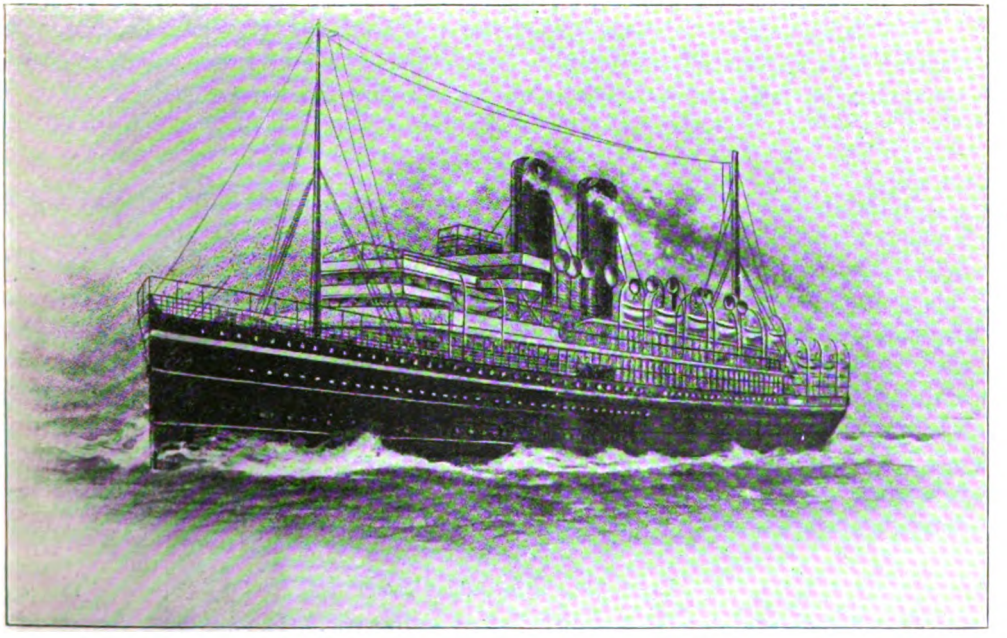
CAPTURED BY MOORS.

In the Admiralty Division recently, before Mr. Justice Bargrave Deane, sitting with the Trinity Masters, an exciting story was narrated of a raid by Moors on the oil tank steamer *Eburna* on the coast of Morocco. A claim for salvage was made by Captain Edward George Lowther-Crofton, D.S.O., and the crew of His Majesty's ship *Caesar*.

The *Eburna* belongs to the Anglo-Saxon Petroleum Company, Limited, London, and has a gross tonnage of 4,735. On the night of May the 13th last she went ashore in Almanza Bay whilst in ballast. The weather was foggy at the time, and early next morning when a boat was returning to the ship it was seized by armed Moors, who took away the boat and its crew, consisting of the second and third officers, six Chinese



THE P. AND O LINER "MALOJA" WHICH WAS MINED IN THE CHANNEL.

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and two European sailors. Other natives in two boats, one being the *Eburna's*, tried to board the steamer, but, although they fired shots from the boat, they were beaten off. The steamer *Richard Welford*, in the service of the Government, came up but was unable to render assistance because her boat and its crew had been captured by the Moors.

A British torpedo-boat came up later and rendered assistance, and shortly after this His Majesty's ship *Caesar*, a battleship, arrived from Gibraltar with marines for the protection of the *Eburna*. We have not space here to detail the exciting incidents which then took place, but our readers will gather some idea of what happened from the fact that the battleship had to open fire on the Moors, and sent armed boats to demand the immediate release of the captured men. Natives who were concealed in considerable force behind rocks and bushes on the hillside and the shore thereupon fired on the boats and tried to carry off the prisoners, but the shell fire from the *Caesar* frustrated their intention.

Negotiations were then reopened with the Moors, who were suspected of procrastinating till darkness set in, when they could make off with the prisoners. Searchlights from the *Caesar*, however, prevented that movement, and about 8.30 at night two prisoners got away and tried to swim to the boats. The Moors fired on them, but an armed cutter picked up the men.

Captain Lowther-Crofton, D.S.O., in the course of his evidence, stated that he had heard by wireless before leaving Gibraltar that the *Richard Welford* had sent ashore a boat with seven or eight men, that one had been killed and the rest were wounded, that the boat had been captured, and, further, that two officers and eight seamen were in the hands of the Moors.

His Lordship, giving judgment, described the services of the *Caesar* as "good and well rendered." The Elder Brethren agreed with him that a fair award would be 4 per cent. of the amount of risk, viz., £4,000, which sum the Court awarded.

This is an instance, extremely romantic in character, in which wireless telegraphy played a most important part. But for Senatore Marconi's invention the timely rescue would probably not have been effected nor such prompt assistance given.

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A PRIZE APPEAL.

In the Judicial Committee of the Privy Council, before Lords Parker of Waddington, Sumner, Parmoor, Wrenbury, and Sir Arthur Channell, the prize appeal case of the *Belgia* came up for consideration. The vessel, which was German owned, was on a voyage from New York to Hamburg, when on August 3rd she heard by wireless that war had broken out between France and Germany. Her master determined to run into the Bristol Channel, and got to Newport the following day, but was not allowed to anchor in the harbour. The next morning war having been meanwhile declared between England and Germany she was brought into Newport as a prize.

The President found that she was captured at sea on the outbreak of hostilities. From that decision the appeal was brought. Sir Robert Finlay, K.C., having been heard for the appellants, judgment was reserved.

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LOSS OF A FRENCH TRANSPORT.

The French review of events of February 29th says :—The auxiliary *Provence II.*, temporarily employed to transport troops to Salonica, was sunk on February 26th in the

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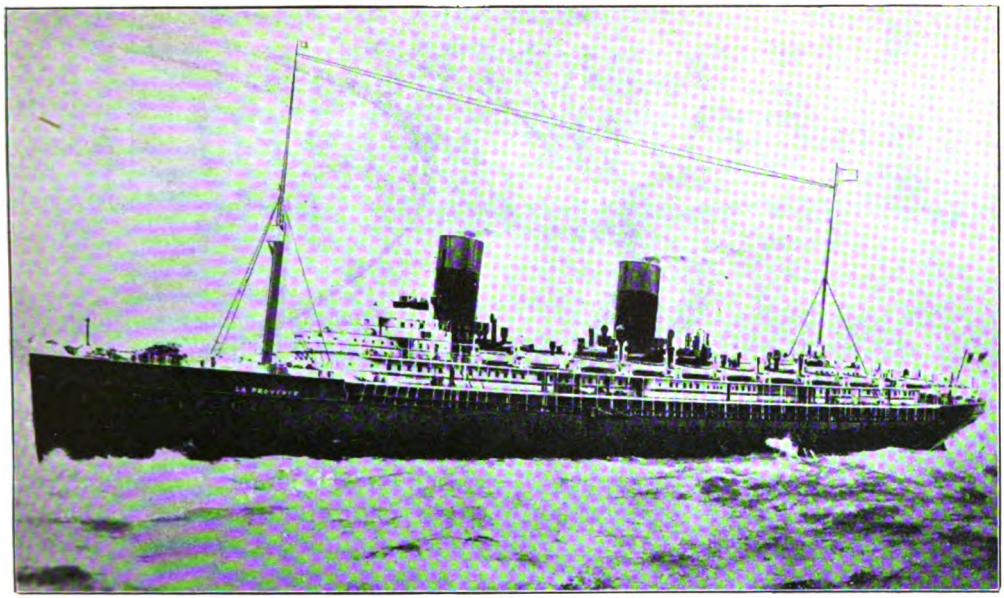

THE FRENCH TRANSPORT "LA PROVENCE," SUNK IN THE MEDITERRANEAN.

Central Mediterranean. According to reports received up to the present 296 survivors were taken to Malta and about 400 to the Island of Milo by French and British trawlers and destroyers on patrol duty, which hastened to the help of the vessel in reply to her wireless calls.

A later *communique* states that according to the latest information there are now at the Island of Milo 489 survivors from the transport *Provence*, and that 85 more are shortly expected there on board a patrol boat. The number of survivors is now believed to be 870.

This steamer, known in peace time as *La Provence*, is of particular interest to wireless men, as it was upon her that some of the earliest experiments with the "Bellini-Tosi" wireless direction finder were carried out. At the time of these tests the apparatus, although extremely ingenious, had many defects, and it was not until later that improvements were made placing the innovation upon a practical and commercial footing.

MARCONI'S WIRELESS TELEGRAPH COMPANY, LTD., announce that deferred plain language telegrams and night and week-end letter telegrams can now again be accepted for Canada and the United States at their offices, 1 Fenchurch Street, E.C., and Marconi House, W.C., and at all post offices.

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NOTES OF THE MONTH

OUR readers will note with interest a number of important changes in the printing of our magazine this month, and we venture to think that they will be generally appreciated. The method of printing the articles right across the page instead of in column form is uncommon in this country, although it is adopted by some of the leading reviews. In a magazine like THE WIRELESS WORLD, however, it has many distinct advantages, not the least important being the clear manner in which formulæ, equations, etc., can be printed. It also enables the illustrations to be used to the best advantage.

A minor change, which we have made in response to several requests, is that of printing the month on each opening, thus facilitating search in the bound volume. Reference is also aided by printing abbreviated title of the articles at the head of the page. We shall welcome any opinions and criticisms from our readers on this and other points.

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The demand for fully-trained wireless operators still continues, and is not to be wondered at when we consider the number of men who have taken up positions in both branches of His Majesty's Forces. Lady operators are being trained for certain branches of wireless work on shore, but at present they are not being appointed to marine duty. Experienced operators and professional wireless men generally will readily realise the difficulties which confront us when we consider placing women for this work on board ship, but, of course, no one can tell what will be done in the future.

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Mr. W. Heath Robinson, whose cartoon we have great pleasure in presenting to our readers in this issue, is in the foremost rank of British black-and-white artists. With an international reputation, his drawings are as well known in the United States as they are in this country, the famous American journal *Puck* publishing many of them. Not only does he produce humorous work of a highly original order, but also exquisite illustrations for fairy tales and stories.

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The wireless operator on arrival at foreign ports often finds himself with considerable spare time upon his hands, and very little with which to occupy it. This is particularly the case in some small foreign ports where sights and scenes ashore offer no attractions. We think that the series of articles included in this number devoted to " Pastimes of Operators " will prove of distinct value. The writer of the first article,

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Mr. W. S. Purser, is a recognised expert with the banjo, and has also had considerable experience at sea as a wireless operator. He therefore writes from practical experience of banjo playing at sea. Next month we hope to publish an article on photography.

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Wireless telegraphy and the wireless operator nowadays make frequent appearance in legitimate drama and vaudeville. The new Empire revue "Follow the Crowd" has its little "wireless" incidents, the popular actor, Mr. Robert Hale, playing the part of a Marconi operator. The wireless man on the stage, by the way, is usually a very different person from the operator of real life, and the professional radio man in the audience is often amused at quite the wrong place.

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By the death of Sir Laurence Gomme, late Clerk of the London County Council, our contemporary *Electricity* is reminded of an article recently written by that gentleman in which he set out to prove that the principles of wireless telegraphy were known to the toilers among the Welsh hills quite one thousand years ago. This, in turn, reminds us of an interesting article in the *Wide World Magazine*, by J. Campbell Besley, entitled "Down the Amazon from Source to Mouth." In this the writer says that wherever his party went the natives seemed prepared for their coming, and on enquiring what means the Indians had for such rapid communication an old native replied, "Wireless, the same as the white man!" The writer was then conducted to a wooded space where crude apparatus was arranged for the transmission of sound waves. Later on Mr. Besley came across many smaller wireless stations. It is not long ago since we published in these pages a short account of a native "wireless" system in Africa. Truly there is nothing new under the sun!

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WE understand that the King in Council has approved of the proposal by the Admiralty that they be authorised to promote warrant telegraphists to commissioned warrant rank in such numbers as shall not exceed 8 per cent. of the total number of commissioned telegraphists and warrant telegraphists combined, until the normal period of service as warrant telegraphist reaches fifteen years, when the provision of the Order in Council of July 19th, 1912 (that warrant officers belonging to classes in which commissioned warrant rank is attainable may advance to commissioned warrant rank after fifteen years' service as a warrant officer) will become applicable.

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There is every indication that the Marconi Official Records will prove a tremendous success. At recent private demonstrations the highest praise has been bestowed upon them by some of the most experienced men in the profession. Being something totally different from anything yet produced, it is not surprising that they create a sense of wonderment in many people who are unacquainted with wireless signals, and it is reported that a foreman at the Gramophone Company's works, on hearing a record after manufacture, immediately took it over to the recording manager to inquire what had gone wrong. He thought the record was a reproduction of some musical instrument!

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To Our Readers

I WONDER whether it has ever struck many of my readers, as it has myself, how much in life depends upon " the point of view." We often speak not only of the " small " troubles of children, but also those of our friends. Yet to children and to our general circle of acquaintances those troubles which appear insignificant to us are sufficient completely to overcloud the sky of their minds and cast a gloomy shadow over their whole mental outlook. The same thing happens to ourselves, and when we look back upon past worries we often wonder how it is that we paid so much attention to them. The whole matter appears to rest upon a point of psychology. We read into outsiders and into institutions, besides into things animate and inanimate, ideas which have their home in our own consciousness. Philosophers dub this point of view " subjectivity," and discourse learnedly about the " subjective outlook." Yet it is no mere matter of deep philosophy, but a feature of our everyday life, and constitutes the cause ultimately responsible for our attributing all kinds of feelings and sensations to objects which in themselves have no feelings or sensations at all. It is this kind of mental attitude which induces people sometimes to speak of " wireless " as though it had a soul of its own " to be saved," and was in possession of moral attributes.

The line of thought indicated above was induced by a certain newspaper heading which ran, " Wireless Blasphemy." My first impression is represented by the question, ' How can wireless blaspheme ? It does not act upon its own initiative, and has no moral code binding upon it; *que diable allait-il faire dans cette galère ?* '

On reading the article, it turned out to be a description of a lecture delivered by Canon Parfitt on the erection of a German wireless station on the Mount of Olives. The reverend gentleman's knowledge of Bible lands gives him a claim to be listened to with respect, and I was exceedingly interested in the article to which my attention was thus directed. Yet it was very plainly evident that intense personal devotion to his Lord and Master, and all places closely associated with Him, was responsible for Canon Parfitt's denunciation. This " blasphemous desecration " aroused in him a sincere and deeply-felt horror of the lack of regard for moral restraints which induced the Germans, in their thirst after world domination, not only to display an absolute lack of feeling of personal reverence, but a complete contempt for that felt by other people.

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The erection of this station formed part of the long-cherished Teutonic scheme for securing dominance over the whole of the Near East, and for obtaining by these means a through route overland to the Persian Gulf, India, and the Far East. The Canon, who has devoted twenty years of labour to the people of Baghdad, Jerusalem and Beyrut, in the course of his lecture demonstrated, with admirable clearness, the length of time and methodical completeness with which this object has been persistently pursued. He even enters into the realms of prophecy, and foretells that so wide and deep are the ramifications of their plot that there is likely to be in the Near East strife and bloodshed arising out of the present war for the next twenty years. In the course of my wanderings through Syria, I saw the Tomb of Saladin, the great Eastern military hero of the Middle Ages, decorated with the German flag left there by the Kaiser himself; and the grotesque German claims to Mohammedan sympathies, and even Mohammedan religious convictions, constitute no new feature in the tortuous machinations of Teutonic diplomacy.

The penetration of the pushful Germans into the Turkish Empire has been forwarded, not only by the two greatest modern aids to territorial development—railways and wireless telegraphy—but also by the process, blasphemous in a self-styled Christian nation, of not merely holding in high reverence the religion of Islam, but also of semi-proselytism to it.

Such was the article whose heading, due probably to the reporting journalists, and not to the Canon himself, gave rise to the thoughts expressed at the opening of these remarks.

The text of Canon Parfitt's lecture diverted my thoughts, however, after perusal, in a different direction, and left the impression that, however philosophically unjustified the term "Wireless Blasphemy" may be, it at all events expresses, in crisp and pregnant phrase, one aspect of the moral degradation with which the present race of Germans is imbued. Whatever military successes might accrue to a people so ethically bankrupt, the doom of one of the great military nations of antiquity must inevitably overtake them—that doom, which was embodied in the handwriting on the wall in Mesopotamia: *Mene! mene! Tekel, Upharsin!*—they have been weighed in the balance and found wanting.

The Editor

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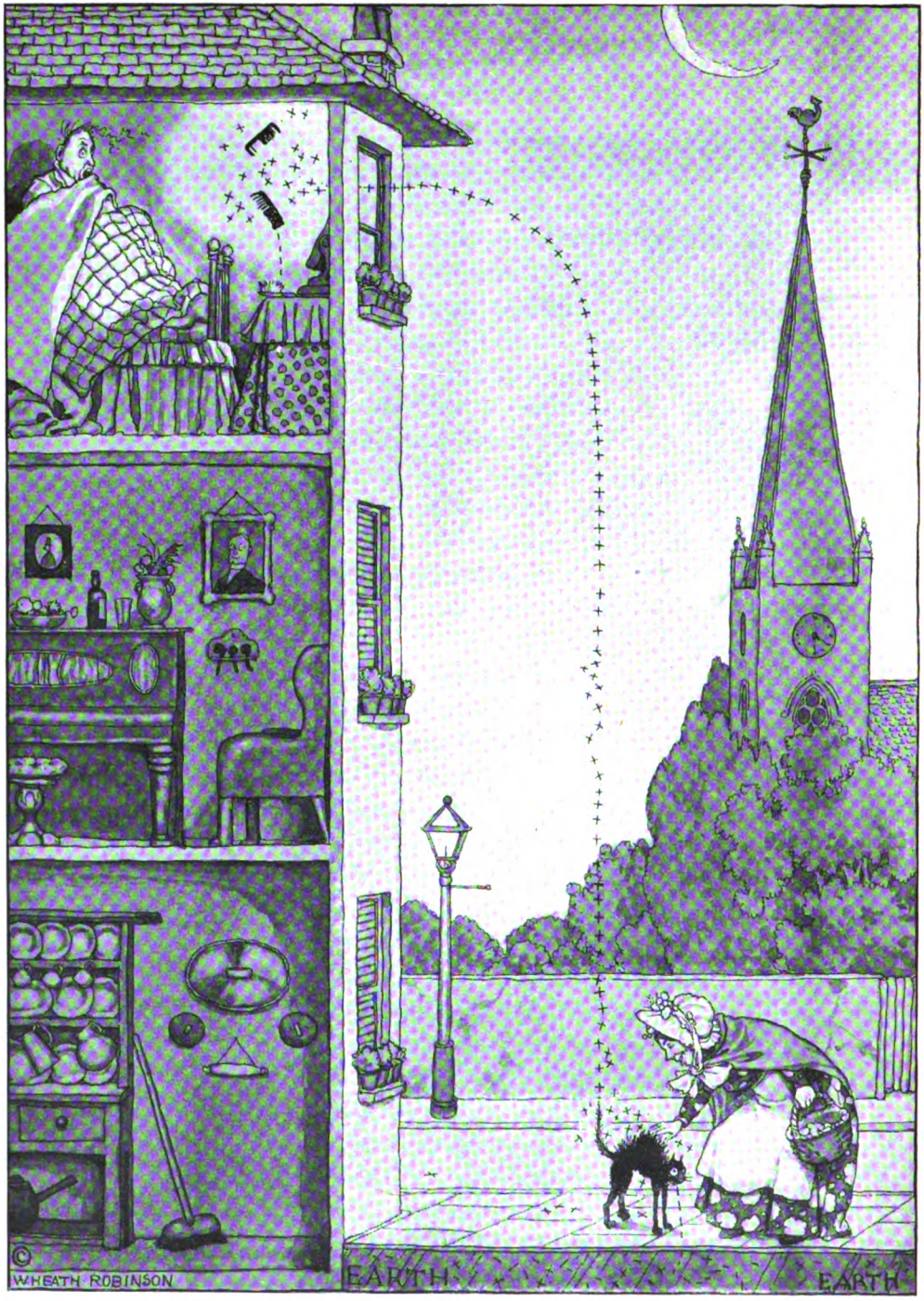

HOW IT WAS DISCOVERED THAT ELECTRICAL INFLUENCE MIGHT BE TRANSMITTED WITHOUT WIRES.

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The Methods Employed for the Wireless Communication of Speech

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institute of Electrical Engineers, on February 2nd, 1916.)

THE communication of speech and other sounds from place to place without the intervention of any wire connection is no novelty, and the method of the ancients is still in use to-day. This transmission of sound by air waves is seldom, however, looked upon as being included under the generally accepted meanings of the term "wireless telephony"; and there is little need, therefore, to devote more consideration to it.

Wireless telephony seems still to be periodically "invented" in the columns of the daily Press, although its first inception dates back to the beginnings of the much better known wireless telegraphy.

The various methods that have been suggested from time to time for effecting telephonic communication between two or more places without the aid of connecting wires may be broadly classified as follows:

(*a*) Conduction and induction methods, employing the conductive connection of the earth or sea, or magnetic induction between circuits:

(*b*) Photophone and thermophone methods employing light or heat waves as the transmitting medium.

(*c*) Wave methods employing æther waves of the same kind as used in ordinary wireless telegraphy.

THE CONDUCTION AND INDUCTION SYSTEMS.

The conduction and induction methods of wireless telephony were obvious extensions of the use of this type of apparatus in the early days of wireless telegraphy: since speech could be effected between the two stations merely by replacing the transmitting key and source of interrupted currents, by a microphone with a suitable battery or generator. It may be convenient to briefly call to mind the arrangements before passing on to a consideration of the more important methods and apparatus.

These methods have been applied, amongst other purposes, for telephoning between the various levels in mines, and it is interesting to note that comparatively recently these systems have been "revived" and successfully utilised for this purpose, the apparatus required being extremely portable and suited to the conditions of use.

PHOTOPHONE AND THERMOPHONE SYSTEMS.

The majority of photophone systems depend on the fact that when light falls on selenium its resistance decreases, in amount depending within limits on the intensity of the illumination. To obtain the best effects it is essential that a considerable surface should be exposed to the action of the light, while, in addition, the cross sectional area through which the current flows should be as large as possible and the length small, on

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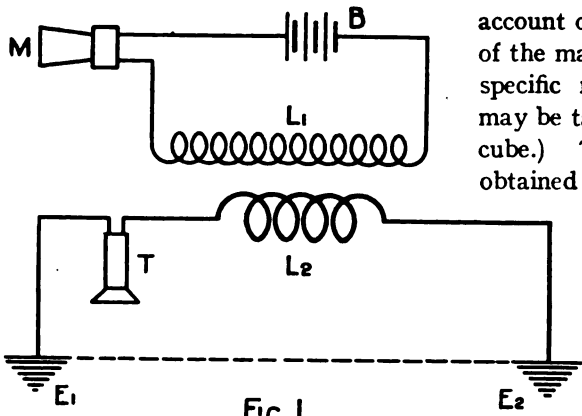


FIG. 1.

ARRANGEMENT FOR CONDUCTION METHOD, USING MICROPHONE TRANSMITTER.

account of the very high specific resistance of the material. (An average value of the specific resistance for crystalline selenium may be taken as about 60,000 ohms per cur. cube.) These results are most conveniently obtained by spreading a thin film of selenium over a number of parallel wires, which form the electrodes of the completed "cell."

One proposed form, due to E. Ruhmer (who carried out a considerable amount of experimental work in this branch of the subject), consists of a spiral of two wires wound round a flat piece of porcelain or mica with a small space between them. The selenium is then spread over them in a fused condition, and annealed by heating the completed cell in order to convert the selenium into the grey crystalline variety, which is more sensitive to light. Another form consists of a pair of wires wound round a cylinder of porcelain, or other suitable material, the selenium being spread over them as in the other type, and subsequently annealed by heating. The wire employed is usually platinum. See Fig. 3.

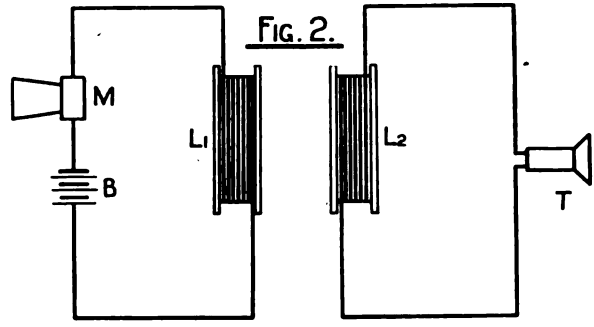
As the change of resistance of the selenium depends on the intensity of the illumination, it is evident that if we can cause the intensity of a beam of light to vary with the modulations of the speech waves, we shall, by connecting a telephone receiver in circuit with the selenium cell, be able to transmit articulate speech along the beam of light.

This, in brief, is the essence of all arrangements of photophones, the differences being mainly in the various light sources employed and in the means of modulating the intensity of the light. Time will not permit, however, of more than a brief mention of one or two of the most important and successful methods.

By employing parabolic mirrors at both the transmitter and receiver, so as to obtain a parallel beam of rays and to utilise as much as possible of the beam at the receiver, the speaking range of this type of apparatus may be increased, but, in any case, is limited to the visibility of the source of light employed.

One of the earliest light sources used for this purpose was a gas flame, from its ease of control by the voice, the arrangement being that of the well-known manometric flame. Its range is, however, of necessity extremely limited, being available for little more than demonstration purposes on account of the feebleness of the light source.

FIG. 2.



ARRANGEMENT FOR INDUCTION METHOD.

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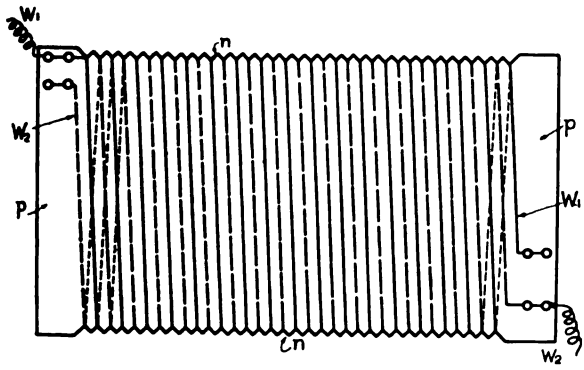

FIG. 3.

The greatest utility of the photophone is obtained when a powerful arc searchlight is employed at the transmitter, the light intensity being modulated by means of an ordinary microphone transmitter acting on the arc current.

In this manner successful working has been obtained up to distances of 20 miles or more. See Fig 4.

A point in connection with the operation of these methods is that it is possible to employ light screens so as to cut off *all* the visible light (or any desired portion of it), and to use, say, merely the invisible infra-red rays. Such an arrangement renders the working very secret, as no outward indications are given at all of the messages passing. A further step from the use of infra-red rays is to employ heat waves only, and a delicate thermopile or similar heat-detecting arrangement (with a telephone) at the receiver. The speaking range of these "thermophones," as they are called, is, however, not nearly so great as that of the photophones employing light waves, while they are not so satisfactory in operation in other ways.

Desiderata for Successful Wireless Telephony by Æther Waves.

We are now led to a consideration of the main branch of our subject this evening—viz., the practical methods of wireless telephony involving the use of long æther waves of the same kind as those commonly utilised in ordinary wireless telegraphy—that is, waves of length within what is customarily called the "wireless range" of, say, 200 or 300 metres up to about 10,000 metres wave-length. (Frequencies between 30,000 and about 1 or 1½ million per second.)

A little investigation, however, soon shows that the problems presented in this case are rather different from those of ordinary wireless telegraphy. An outline of the requirements may be given as follows:

At the transmitter must be set up a stream of æther waves suitable for affecting the distant receiver (much as in wireless telegraphy by the same means). This stream of waves will produce a certain continuous effect at the receiver. It is necessary, therefore, to modulate this stream of waves, according to the modulations of the speech or sound waves, just as the light of the arc is modulated in the photophone transmitter to produce at the

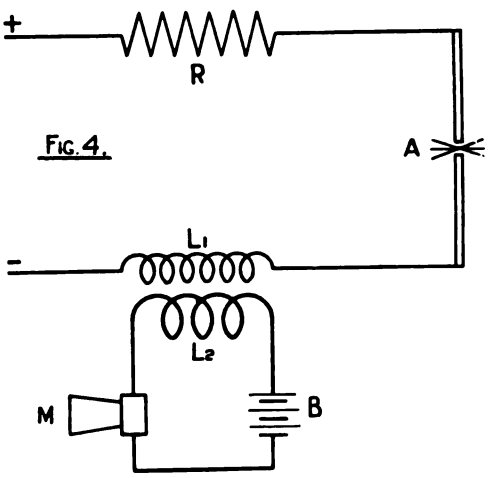

FIG. 4.

DIAGRAM OF "TALKING ARC" CONNECTIONS.

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receiver effects which are a more or less faithful copy of the speech or sound waves impinging on the transmitter, and which may, therefore, be made audible by the use of the customary telephone receivers. (Fig. 5)

The practical realisation of the above is not, however, as simple as it appears at first sight. To begin with, we have to produce a perfectly steady stream of waves at the transmitter, which shall be capable of affecting the receiver, but which must *not produce any sounds in the receiving telephones* under normal conditions—*i.e.*, when no speech is being transmitted; this means either that the waves emitted must be perfectly continuous (like an ordinary alternating current), the frequency, of course, being above the acoustic limit of about 30,000 per second, or, that if the wave emission is discontinuous (as in ordinary spark wireless telegraphy), the successive groups of sparks must follow one another so quickly that the "sound" they give rise to in the receiving telephones is above the acoustic limit, and so inaudible.

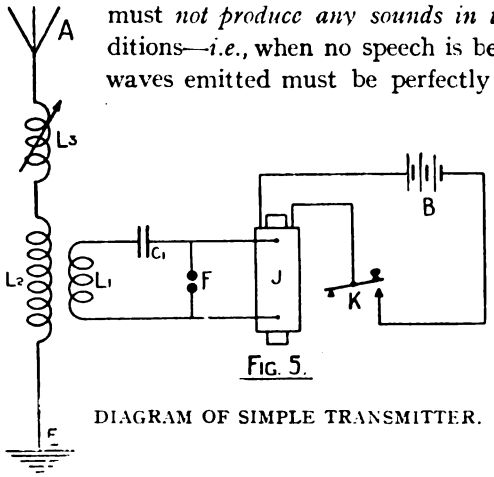


FIG. 5.

DIAGRAM OF SIMPLE TRANSMITTER.

Hence we see at once that the transmitting apparatus for æther wave wireless telephony may be roughly divided into two main classes:

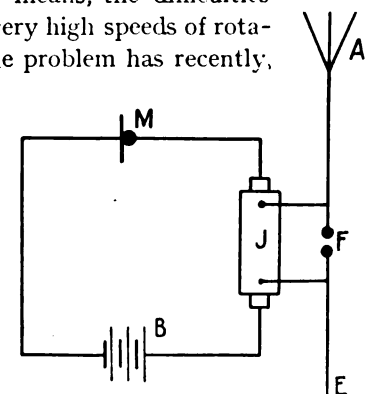
1. Those producing continuous waves; and
2. Those producing discontinuous groups of waves of very high group frequency.

The practical realisation of either of these methods involves considerable departure from the usual apparatus of ordinary musical note-spark telegraphy in the majority of cases, as, for example, considerable difficulties are at once introduced if we attempt to raise the spark or group frequency much above the values that are customarily employed —*i.e.*, up to, say, 1,000 sparks per second. More especially is this the case if we attempt to employ some form of rotary spark gap—such as the Marconi disc discharger—to produce these very high spark frequencies by direct means, the difficulties being mainly in the mechanical construction for the very high speeds of rotation that would be necessary. A means of solving the problem has recently, however, been discovered, which promises successful operation. This will be referred to later in the paper.

Hence other methods of generating the required oscillations must generally be resorted to. They may be classified as follows:

For generating continuous waves we have—

1. Arc apparatus;
2. Alternator and frequency raising apparatus; and
3. "Vacuum methods," involving the employment of and electrical discharge through a rarefied gas or vacuum.



EARLY SPARK TRANSMITTER WITH MICROPHONE.

FIG. 6.

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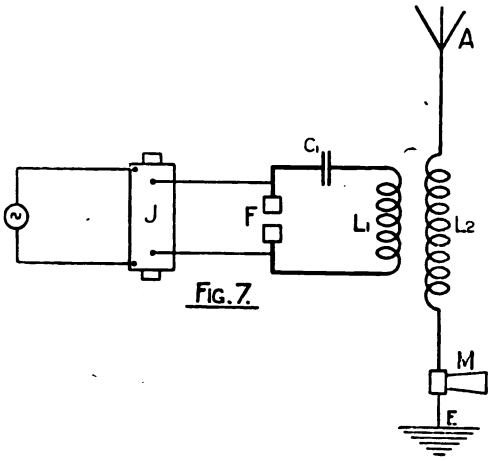

FIG. 7.

For generating discontinuous waves of high group frequency we have—

4. Short spark methods, generally employing some form of quenched spark gap.

The above classification, however, must not be looked upon as an absolutely rigid one, as we find that several of the available pieces of apparatus do not strictly belong to either class. For instance, it is usually understood that the expression "discontinuous groups of waves" implies a succession of wave trains, each of which dies out completely before the succeeding one commences; whereas some apparatus usually referred to this class really produces a rapid series of trains of oscillations which run into one another, giving rise to waves of fluctuating amplitude which do not actually die out at any time.

On the other hand, we shall find that some of the short-spark methods (usually classed as producing discontinuous waves), really generate oscillations which, to all intents and purposes, may be said to be undamped. The classification must therefore only be looked upon as one to assist the treatment of the subject from the descriptive point of view.

Almost as soon as Marconi first outlined his schemes for wireless telegraphy several proposals were put forward for enabling telephonic communication to be carried out by the same means.* The majority of them merely consisted in taking the ordinary wireless telegraphy transmitter in use about that time and adding to it some means of modifying the emission of the waves, according to the sounds to be transmitted. The following diagram shows one proposal in this connection, and may serve as an illustration of the methods adopted. It consists of a simple wireless telegraph transmitter, with the addition of a microphone connected in the supply circuit to the induction coil, instead of the usual interrupter, the idea being that the changes of microphone resistance produced by the sounds to be transmitted would cause sparks to pass across the gap of the required strength and frequency to transmit the sound waves. (See Fig. 6.) As a receiver, any one of the microphonic contact or auto-decohering detectors in common use about that time (*i.e.*, about 1900 to 1905) was employed in conjunction with a telephone receiver. A certain measure of success was obtained in that rhythmic sounds or notes could be transmitted, but articulate speech was practically out of the question since the wave form of speech is far too irregular for the combination of induction coil and open spark gap to follow with any measure of success.

Other proposals involved the addition of a microphone to a wireless telegraph transmitter while retaining the induction coil with its interrupter. (Fig. 7.)

The obvious disadvantage of this arrangement is that the microphone can only operate during a train of oscillations, while in the relatively long interval between the successive wave trains it can produce no effect whatever. Hence, any speech or other

* See, for example, U.S.A. Patent, 14540, 1906; French Patent, 365100, 1906; British Patent, 28955, 1896; German Patent, 138226, 1901. *Electrotechnische Zeitschrift*, 25, p. 1085; and 26, p. 65, 1905.

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sounds received will be extremely imperfect (it has been found that some musical notes can be transmitted in this way, but not speech), while in addition there will be the continuous noise of the spark, corresponding to the frequency of the induction coil interrupter, which will be received the whole time.

In short, it may be seen at once that such an arrangement does not comply with the requirements laid down above for the successful working of wireless telephony by æther waves.

In passing it may be mentioned here that the connection of the transmitting microphone in the aerial circuit of the transmitter, as here shown, is now most commonly employed with success with the modern transmitters—the fault in this case lies not in the connections, but in the oscillation generator. In endeavouring to overcome the above difficulties of low spark frequencies, attempts were made to replace the original induction coils by alternating current transformers, with the spark gaps so arranged that a considerable number of discharges took place in each half cycle of the voltage wave, which should preferably approach a rectangular shape rather than the usual sine curve.

The addition of two or more spark gaps, and oscillation circuits (all influencing the same aerial), and fed from a three phase, or polyphase, alternating current enables the spaces which occur near the zero of each half wave of the A.C. voltage to be filled up, and the effective sparking rate rendered nearly uniform.

It is interesting to note that these methods have comparatively recently been revived and applied to more modern apparatus than that for which they were originally intended. By employing a suitable design of spark gap it has been found possible to obtain sufficiently rapid discharges to enable intelligible speech to be transmitted over short distances.

The employment of three phase alternating currents, with three spark-gaps and oscillation circuits, has also been more usefully applied in conjunction with modern alternators designed to deliver 5,000 to 10,000 cycles per second, and using quenched spark-gaps properly tuned to give uniform sparking once on each half wave of the alternating current. It is possible to obtain in this manner a very uniform regular group frequency, which may be above the acoustic limit, and therefore suitable for the transmission of speech.* (*To be Continued.*)

WAR INVENTIONS.

MESSRS. J. S. WITHERS & SPOONER, patent agents, of Staple House, Chancery Lane, London, have just published a little book entitled *War Inventions—How You can Assist.*

The purpose of the book is to remind the public that war inventions have been officially encouraged by the appointment of the Inventions Boards for the Ministry of Munitions, the War Office and the Admiralty, and all inventions likely to be of assistance in the prosecution of the War are receiving favourable consideration.

All of our readers who exercise their ingenuity in endeavouring to produce inventions of service in this terrible War, will be interested in the notes on those things which are most acceptable in the present time.

We understand that a free copy of the booklet can be had on application to the above address.

* See Eisenstein, U.S. Patent, 99183, 1911; also *Proc. Inst. Radio Engineers*, 2 pp., 217 and 235; *Sci. Abs.*, 18 B, No. 728, 1915. See also E. G. Gage, *The Electrician*, 73, p. 731, 1914.

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Among the Operators

OPERATOR G. W. INGLE.

LOSS OF THE S.S. "MALOJA."

We are happy to be able to announce that both operators of the great P. & O. liner *Maloja*, which was recently mined in the Channel, have been saved and sustained no injuries. The senior operator, Mr. George William Ingle, is nearly 24 years of age and is a native of Bradford. He received his education in his native town, and later took up a course of wireless telegraphy at the Fallowfield Wireless Training College, from which he proceeded to the Marconi Company's London School in October, 1913. In November of that year he received his first appointment to the *s.s. Guildford Castle*, in the following year transferring to the *s.s. Indus*, and again after some months to the *s.s. Nankin*. He then served successively on the *s.s. Corinthian, Egypt, Sicilian, Medina, Marina* and *Admarina*, receiving his appointment to the *Maloja* in February of this year. Considering how rapidly the ill-fated liner sank after striking the mine, and in view of the high death-roll, Mr. Ingle is to be congratulated on what was undoubtedly a remarkable escape. The junior operator, Mr. Frederick Roberts Garden, is a new recruit to the Marconi service, having joined as recently as January of this year. Born in Edinburgh, he is 22 years of age, and received his first wireless training at the North British Wireless School, Edinburgh. The *Maloja* was the first ship on which he had served, and he also is to be congratulated upon his very lucky escape.

Both men had some thrilling experiences between the time that the ship was struck and their rescue. Mr. Ingle spent a considerable time in the water, being among the last to be picked up by the rescuing vessels.

A third wireless operator was on board the mined liner, Mr. James Orr Rankin, who was proceeding by that vessel to take up an appointment abroad. Mr. Rankin unfortunately sustained injuries to his foot, spraining his ankle while getting away from the sinking liner. After being in the water for between ten and fifteen minutes in a heavy sea, he managed to clamber into one of the ship's boats which drifted his way. Mr. Rankin joined the Marconi Company in July last and served for some time upon the *s.s. Beltana.*

OPERATOR F. R. GARDEN.

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OPERATOR R. F. MCLENNAN.

S.S. "FLAMENCO."

The story of the sinking of the *s.s. Flamenco* by the German raider *Moewe* will already be known to most of our readers. The operator, Mr. Robert Frederick McLennan, was fortunately saved and received no injury during his exciting experience. Mr. McLennan, whose home is in County Wexford, will attain his majority in August next. He joined the Marconi Company's London School a few months prior to the outbreak of war and was appointed to his first ship, the *s.s. Gloucester Castle*, in May, 1914. Before taking up duties on the *s.s. Flamenco* Mr. McLennan served on the *s.s. Oxfordshire, Manchester City*, and *Benefactor*.

* * * *

S.S. "BOLTON CASTLE."

Many of our readers will have read with indignation of the fire in New York on board the *s.s. Bolton Castle*, which was undoubtedly caused by some of Count Bernstorff's agents. Mr. George William Nicholas, wireless operator, fortunately received no injury, although he must have had a very narrow escape. Mr. Nicholas is a Pembroke man, and is 24 years of age. After receiving a course of training at the East London Telegraph Training College he joined the Marconi School in September, 1913, receiving his appointment to the staff early in the following year.

* * * * * *

S.S. "NELLORE."

The wireless operator on board the P. & O. liner which recently caught fire was Mr. M. E. O'Carroll. Mr. O'Carroll is a Dublin man, and received his education at Dumfries, N.B., and took up the study of wireless at the British School of Telegraphy, Clapham Road, entering the Marconi Company's London School in April, 1913. He completed his training and was appointed to the *s.s. Letitia* in June of that year. He afterwards served on the *s.s. Columbian, Scandinavian* and *Cassandra*, receiving his appointment to the *s.s. Nellore* in August of last year.

* * * *

A CORRECTION.

We regret that through an editorial slip in our note of last month regarding the *s.s. Norseman* we referred to Mr. J. R. Oliver as the senior and Mr. F. T. Browne as the junior; this should have read Mr. F. T. Browne senior, and Mr. J. R. Oliver junior.

OPERATOR G. W. NICHOLAS.

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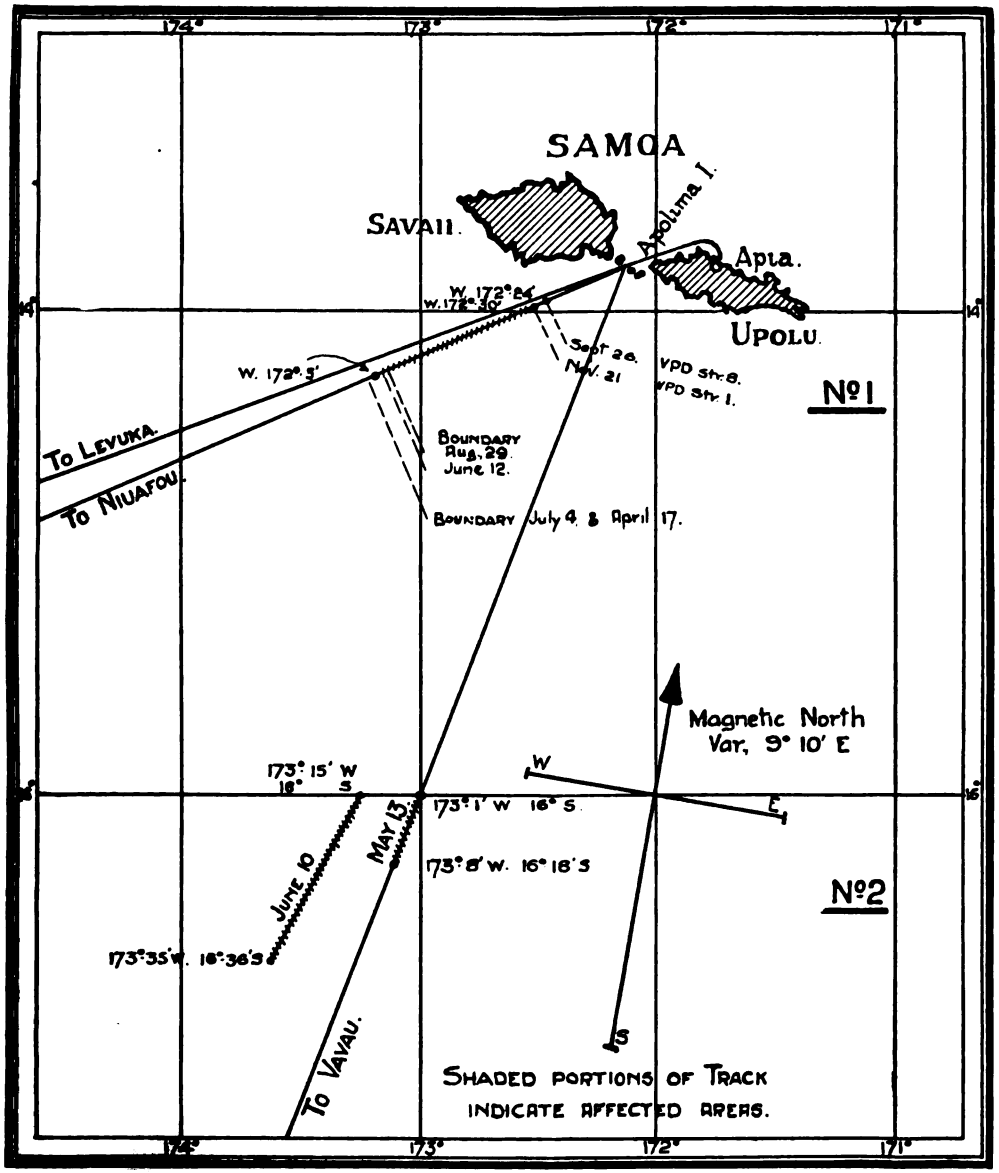
Asymmetrical Transmission Phenomena.

Some Interesting Investigations in the Southern Seas.

FROM time to time Wireless Operators at sea have discovered what may be termed "blind spots" where it seems impossible to receive signals from distant stations, which are, however, heard loudly on both sides of these places. Careful observations have, nevertheless, rarely been made and therefore it is with great pleasure that we are



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enabled to present our readers this month with a most interesting report of observations made during the course of ordinary radiotelegraphic working round the Fiji, Tonga and Samoa Islands. The report and diagrams given herewith are reproduced by the courtesy of Mr. F. Basil Cooke, F.R.A.S., of the Observatory, Sydney, New South Wales, to whom the report was made, and it is hoped that any of our readers who have made similar observations will communicate them to us for publication.

NOTES ON OBSERVATIONS MADE ON BOARD S.S. "ATUA" FROM APRIL TO NOVEMBER, 1915.

From a series of observations made during the course of ordinary radiotelegraphic working round the Fiji, Tonga and Samoa Islands, it would appear that certain areas of open sea exist wherein communication with all stations west of the meridian is greatly hampered, whereas stations situated east of the same meridian are not affected at all. The position of these areas would appear to remain constant from time to time, and their boundaries seem to be fairly sharply defined. The unidirectional effect is quite constant and is most marked, the ratio of the strength of affected signals to the normal being fully 1 : 9. Several of these areas have been encountered by the writer, all operating in the same manner and direction; but owing to the lack of any regular system of experiments with the stations affected the data obtainable are somewhat restricted. The area denoted on the accompanying sketch map as No. 1 has provided the most definite series of observations, and is situated on the steamer track from Apia (Samoa) to Levuka (Fiji). Its western boundary cuts the track at 173·5 W. longitude and 14·16 S., these two points being about 45 miles apart. Stations of which observations were made were :—

West of Meridian.—Suva (Fiji) and Awanui (N.Z.).
East of Meridian.—Apia (British Samoa), Pago Pago (American Samoa) and s.s. *Marama*, near Rarotonga.

On four occasions (April 17th, June 12th, July 4th and August 1st), Suva radio happened to be working just as the *Atua* was leaving the area on the western side, as evidenced by the steady increase in strength of signals. The ship's positions at these times, taken by dead reckoning, are found to fall within a total distance of four miles, which may easily be accounted for by inaccuracy in time, etc. It would seem, therefore, that the location of the area is quite constant. The time taken for signals to rise from minimum to maximum is usually about an hour, which would be equivalent to 10 or 12 miles run. The eastern boundary has not been so clearly located, but appears to lie between 172·24 W., where Suva was strength 8, and 172·30, where he was strength 1.

Both outgoing and incoming signals are similarly affected whilst in the area—*i.e.*, Suva does not hear the *Atua* if called therefrom, though there is no difficulty in working *across* the area—*i.e.*, from beyond the eastern boundary. As a particular instance of the contrast between western and eastern signals: on May 15th, whilst well within the area and unable to communicate with Suva at all, s.s. *Marama* was heard working near Rarotonga, a distance of some 1,000 miles and *east* from the *Atua*. The two other eastern stations, Apia and Pago Pago, are not affected at all.

Another similar area (shown on sketch as No. 2) was observed between Vavau and Apia; the eastern and western boundaries being observed at 173·3 W. 16·0 S. and 173·35 W. 16·36 S. respectively. This may be a continuation of No. 1. If so, it may

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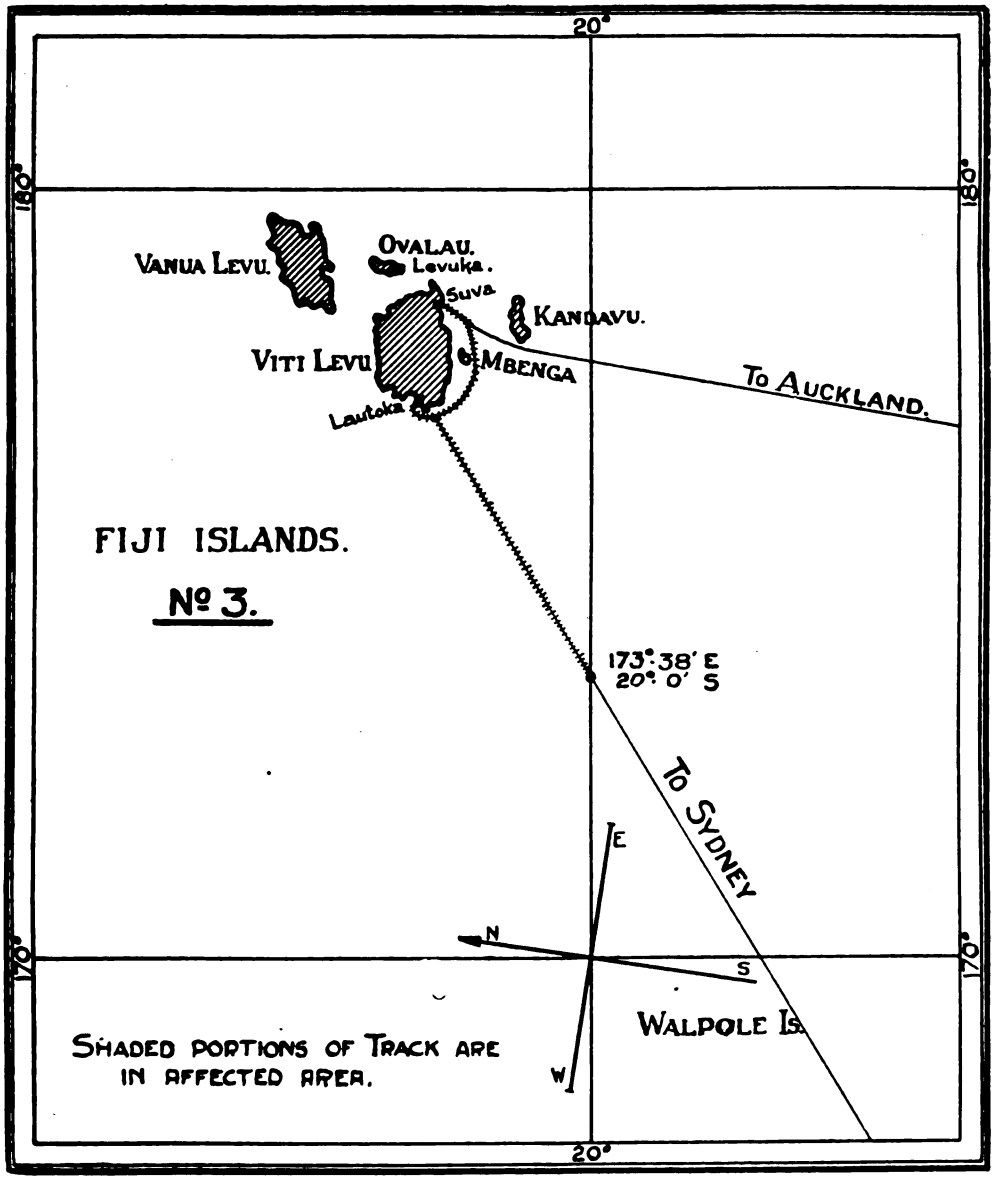

be noted that its bearing thereto lies almost exactly parallel to the magnetic meridian at that locality.

With regard to Awanui, which lies south and slightly *west* from both the above areas, signals therefrom are similarly affected, more especially the 1800-metre wave, this falling to about one-quarter value. The 600-metre wave is not nearly so badly affected, falling to about half value only. It may be noted that in neither case is the effect so marked as with Suva, farther west.

There seems also to be a third area of large extent (sketch map No. 3), encountered on leaving Lautoka for Sydney, and lasting for about 20 hours out, say 250 miles. Here no western signals are ever heard, though Brisbane and Noumea should be quite

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audible at the distance. Beyond this limit, which on one occasion was reached in the middle of the evening watch, Brisbane comes in up to strength 10 (over 1,200 miles) and Noumea about 9, also many ship stations between Sydney and New Zealand and on the eastern coast of Australia. This actually occurred in the instance referred to (August 5th). The position of this boundary would be about 173·38 E. 20 S.

Within the affected area, Suva, Pago Pago, and Apia's 1800-metre wave (all from the eastward) come in very well throughout. Apia's 600-metre wave is too badly screened to be heard in any case. The area also includes the whole of the track from Suva to Lautoka.

A glance at the map will show that there can be no question of screening in the ordinary sense in connection with these areas, as in most cases there is no land at all intervening, particularly that of Suva radio, which faces the sea on the east side of the island. There is nothing about the locality or in the composition of the sea floor to suggest any explanation of the phenomena recorded, and these observations are therefore simply set forth without any theory being at present formulated thereon.

Wireless in the Royal Naval Air Service.

WE understand from *The Times* that boy mechanics are immediately required for training as wireless telegraphists in the Royal Naval Air Service. Applicants must be between 17 and 17½ years of age in March, 1916, and service is for the period of the war only. Applications should be made to the Wireless Officer, Royal Naval Air Service Depot, Barlby Road, North Kensington.

Serbia's Need.

To avoid any possibility of confusion in the administration of contributions intended for the benefit of the distressed Serbian population, the Serbian Legation requests that subscriptions intended for the Serbian Relief Fund, of which H.M. the Queen is Patroness, should be sent to the Earl of Desart, K.C.B., at the Offices of the Fund, 5 Cromwell Road, South Kensington, S.W.

The Serbian Legation will continue to receive subscriptions for the following Serbian Funds:

1. The Archbishop of Belgrade's Fund for the families of the killed and wounded soldiers.
2. The Society of the Serbian Red Cross.
3. The Parliamentary Commission for the Refugees.
4. The Society of St. Helena for the orphans whose parents have been killed in the war.

All contributions addressed to the Serbian Legation (195 Queen's Gate, London, S.W.) for these Funds will be gratefully received and acknowledged.

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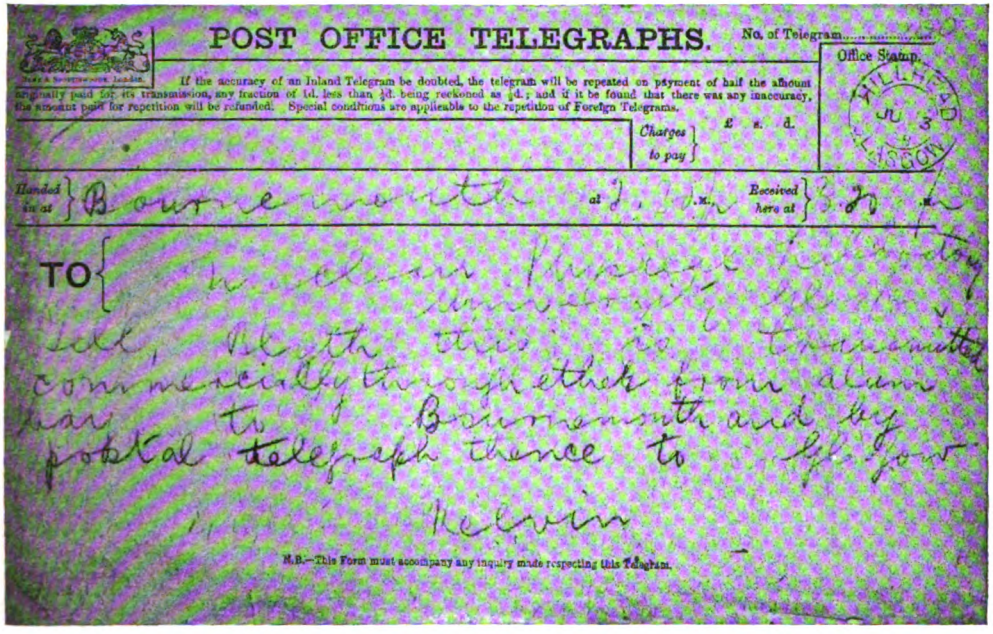
Some Famous Messages and Records.

A Short Article concerning the Earliest Marconigrams.

In the Christmas number of THE WIRELESS WORLD we had pleasure in presenting to our readers, under the title of "1896–1915," an article containing many unique photographs, including one of the first paid wireless message, sent by Lord Kelvin. The interest aroused by this article prompts us to reproduce one or two further illustrations of historic importance, and by the courtesy of Professor Magnus Maclean, of Glasgow University, whose biography and portrait we publish in this issue, we are enabled to show just how Lord Kelvin's famous message appeared when delivered to him in Glasgow.

Professor Maclean very kindly informs us that at that time he and Mr. Blyth (to whom reference is made in the message) were experimenting on different forms of coherers as well as on the direction of greatest sensitiveness from transmitters. In the words of the communication given to the Royal Philosophical Society, Glasgow,* they


POST OFFICE TELEGRAPHS.

No. of Telegram.....

Office Stamp.

If the accuracy of an Inland Telegram be doubted, the telegram will be repeated on payment of half the amount originally paid for its transmission, any fraction of 1d. less than ½d. being reckoned as ½d.; and if it be found that there was any inaccuracy, the amount paid for repetition will be refunded. Special conditions are applicable to the repetition of Foreign Telegrams.

Charges to pay £ s. d.

Handed in at Bourne mouth at ... M.

Received here at ... M.

TO

Kelvin

M.B.—This Form must accompany any inquiry made respecting this Telegram.

THE FAMOUS MESSAGE SENT BY THE LATE LORD KELVIN TO PROFESSOR MAGNUS MACLEAN, OF GLASGOW UNIVERSITY.

were experimenting on different forms of coherers and on different forms of spark producers affecting coherers at different distances, with the object of determining the direction in which the oscillations died out most rapidly.

In these circumstances our readers will readily understand that such a message proved of exceptional interest to the recipient.

The reproduction of a page of the Needles Station Visitors' Book contains famous names, Professor Popoff and Professor Branly (of coherer fame) having

* "Electric Methods of Space Telegraphy, and Results of Some Experiments on Coherers."

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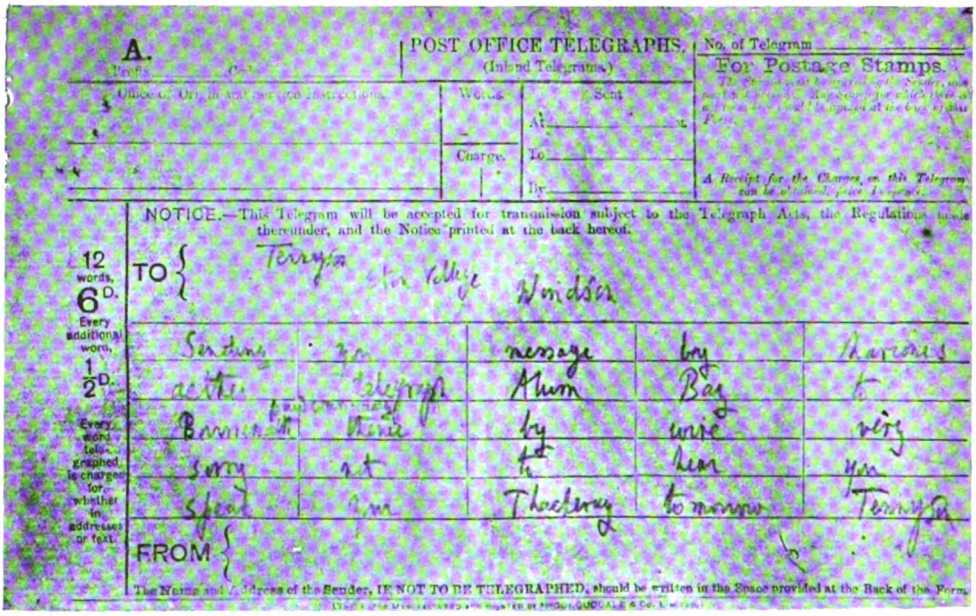
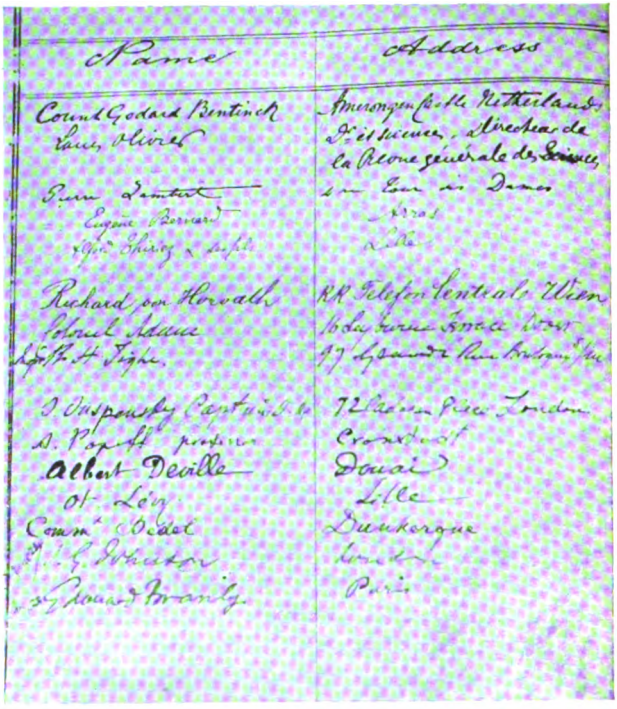

A. POST OFFICE TELEGRAPHS. (Inland Telegrams.) No. of Telegram
For Postage Stamps.
Office of Origin and Service Instructions. Words. Sent At
Charge. To
By
A Receipt for the Charge on this Telegram can be obtained at the Office for an additional Fee.
NOTICE.—This Telegram will be accepted for transmission subject to the Telegraph Acts, the Regulations made thereunder, and the Notice printed at the back hereof.
12 words, 6D. Every additional word, 1/2D. Every word telegraphed is charged for whether in addresses or text.
TO Tennyson Esq Eton College Windsor
Sentence message by Marconi
Better Telegraph Atlantic Bay to
Barrister Time by wireless way
Sorry not to hear him
Speed Sun Thursday to morrow Tennyson
FROM
The Name and Address of the Sender, IF NOT TO BE TELEGRAPHED, should be written in the Space provided at the Back of the Form.

MARCONIGRAM SENT BY LORD TENNYSON (SON OF THE FAMOUS POET) IN 1898 TO HIS SON, WHO WAS A STUDENT AT ETON COLLEGE AT THAT DATE.

both signed the same page. It is more than probable that neither of these gentlemen realised the gigantic strides that this new form of communication would make within the next twenty years.

Among the many guests present about this time was Lord Tennyson, son of the famous Poet Laureate. It so happened that the son of the former was then at Eton, and we can well imagine the curiosity aroused within the walls of that famous school when young Tennyson received the telegram by "Marconi's Æther Telegraph." It will be noticed that in this case the message is written out on a Post Office form, and not on a sheet of writing-paper, as was that sent by Lord Kelvin, and reproduced in the Christmas Number.


Name Address
Count Godard Bentinck
Richard von Horvath
Colonel Suisse
Capt. H. Jeffe
A. Popoff
Achat Deville
Comm. Dedet
E. J. G. Wheeler
Edward Branly
Amsterdam
Rotterdam
Utrecht
Leiden
Groningen
Arnhem
Haarlem
Den Haag
Delft
Rijswijk
Scheveningen
Leeuwarden
Zwolle
Tilburg
Breda
Nijmegen
Maastricht
K.K. Telefon Centrale Wien
Paris
Boulogne
Calais
Dunkerque
Lille
Douai
Crandelain
Valenciennes
Maubeuge
Hirson
Rethel
Reims
Epernay
Chalons
Vitry le François
Bar le Duc
Commercy
Toul
Nancy
Luneville
Epinal
Remiremont
Belfort
Montbeliard
Besançon
Dole
Dijon
Chatillon
Troyes
Nogent
Provins
Melun
Fontainebleau
Versailles
Paris
72 Queen Victoria Street London E.C.

PAGE OF THE NEEDLES STATION VISITORS' BOOK. OBSERVE SIGNATURES OF PROFESSORS POPOFF AND BRANLY.

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Foreign and Colonial Notes.

UNITED STATES.

The Government of the United States of America has asked Congress to appropriate nearly one million dollars for the purchase of the rights in the Hammond Radio-Controlled Torpedo. This torpedo is controlled from an aeroplane at any height.

* * * * * *

Government control of all wireless telegraph stations in the United States, Sout and Central America was advocated by Mr. J. Daniels, Secretary of the Navy, in addressing the delegates of the Pan-American Scientific Congress in Washington last January.

* * * * * *

A dinner was recently given to the wireless telephone engineers who were instrumental in making international wireless telephony a success in October last. At the end of the speakers' table were facsimile reproductions of the Arlington Naval Station from which the messages were sent and of the Eiffel Tower at Paris where they were received.

* * * * * *

The latest development in the management of modern restaurants is the giving of orders for dinner by wireless. An eating-house in New York has announced that passengers on steamships bound for that city can make arrangements by a wireless message to have the table set before they arrive.

* * * * * *

Wireless telegraphy has been put to many peculiar uses, chief amongst which is probably the following: The son of a man living at Edwardsville, Mo., contracted smallpox, and, by order of the Board of Health authorities, the house was closed and the family isolated. A wireless set was installed on the premises and another at the home of a friend on the other side of the town. The inmates of the closed house have thus been able to signal their orders for groceries and other necessaries to their obliging friend, who sees that the orders are transmitted to their destination.

* * * * * *

There have been recently many indications that the American amateur wireless operators—now numbered in thousands—are beginning to realise the important part which they may be able to play in their country's defence. Moved, no doubt, by recent stirring speeches on preparedness, a large number of amateurs and students met on February 2nd in New York to form the Junior American Signal Corps. Addresses were given by Wireless and Signal Corps officers.

* * * * * *

According to the *Telegraph and Telephone Age*, Josephus Daniels, Secretary of the Navy, has signed a memorandum embodying a plan to establish a complete system of radiotelegraphic communication between the United States and other republics of the Western hemisphere. The plan is to be submitted to delegates representing eighteen foreign countries, who attended the Pan-American Radio Conference held in

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Washington in connection with the sessions of the Pan-American Scientific Congress. These delegates will submit the plan to their respective Governments.

* * * * * *

Lieut. W. Furlong, Fleet Radio Officer, is in charge of wireless telephone communication between the U.S.A. battleships *Wyoming* and *Texas*. This method of communication is being used to transmit orders in the manœuvres off Guantanamo.

* * * * * *

The Bureau of Standards at Washington is announced to have developed a radio direction-finder, simple and practical and at the same time efficient. There appears to be no evidence in the statements so far issued that it operates in any manner different from that of the " Marconi-Bellini-Tosi " direction-finder, which has been in practical use for some time, and with which splendid results have been obtained, as our readers know.

* * * * * *

FRENCH COLONIAL.

The French Government has undertaken the construction of a radiotelegraph station at Tahiti (Society Islands) which will soon be in position to receive and transmit messages. The plans of the temporary station at present under construction allow for an installation of a power of 10 kilowatts, employing the French State system with a wave-length of 600 metres. The two masts will be 300 feet in height and the station will be in a position to communicate with New Zealand, the Fiji Islands and Samoa. As soon as the temporary station is finished the erection of a much larger permanent station will be proceeded with. This will have a power of 300 kilowatts and will employ an oil engine of 500 horse power. The station will have eight towers, 300 feet high, arranged in two parallel lines of four towers each. The towers in the same line will be placed at a distance of 750 feet from one another and at a distance of 600 feet from the other line. There will be two aerials, one for a 600-metre wave-length and the other for that of 2,500 metres. The permanent station will most probably enter into communication with Cochin China, South America, Honolulu, San Francisco, Sydney (Australia), and the Martinique and Guadeloupe.

* * * * * *

URUGUAY.

The Government has just submitted to the Chambers for confirmation an *ad referendum* contract with an American company for the erection and working in Montevideo of an ultra-powerful wireless station exclusively for intercontinental service. The State undertakes to grant the permission for a term of thirty years without this implying any monopoly or special privilege in favour of the company. The latter, for its part, undertakes to establish a station as powerful as the most powerful erected in South America and to organise its working in a form which will not prejudice in any way the State wireless service.—*South American Journal.*

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Instructional Article.

NEW SERIES (No. 8).

The following series, of which the article below forms the eighth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

VECTORS.

51. Many physical quantities such as temperature, mass, or volume can be completely described by a number which gives their value to some convenient scale. Such quantities are called *scalar* quantities.

On the other hand, quantities such as velocity, acceleration or displacement can only be completely described by stating their *magnitude*, *direction*, and "*sense.*" Such quantities are called *Vector* quantities.

Consider the line *AB* in Fig. 31, representing, say, a displacement or movement from *A* to *B*. It is obviously not the same as a displacement from *A* to *C*, for the *magnitudes* or *distances* are unequal, though the directions are the same; it is not the same as *A* to *D*, for the *directions* are different, though the distances are equal. Lastly, it is not the same as a displacement from *B* to *A*, for though the distances and directions are the same the "*senses*" are opposite. Thus, in order to completely describe a displacement we must give: (1) Its magnitude; (2) its direction; and (3) its sense.

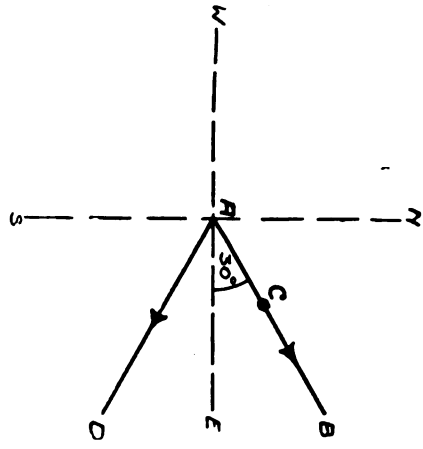

FIG. 31.

52. A vector quantity can be represented by a straight line, and this line has a definite length and direction, but has no fixed position in space. An arrow head should be added to show the sense.

As a very simple example, the line *AB* in Fig. 31, being 1½ inch long, could represent, say, a velocity of 150 miles per hour, in a direction 30° north of east, if the linear scale adopted was 1 inch = 100 miles per hour. If, again, the scale was 1 inch = acceleration of 2 metres per sec. per sec., then *AB* would represent an acceleration of 3 metres per sec. per sec. in the same direction, and so on.

53. Since the direction and sense of a vector are so important, we need some simple method of specifying them. The convention used is as follows:

From any central point, *O*, Fig. 32, a straight line, *OP*, is drawn to what would be the east if the figure were a map. This line is taken as the zero from which all the vectors are specified, and the two items given in the specification are:

(1) The *magnitude*; (2) the angle through which *OP* would have to turn in order to point in the same direction as the vector in question. This second quantity, it will be seen, gives both the *direction* and *sense*.

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Thus, a vector A, 100 units in length, and pointing in a direction 40° "north of east," will be represented by OQ (*not* by OW, which equals $-A$).

A vector B of 50 units' length in a direction 10° "north of west" is represented by OR, 170° from OP (*not* by OX, which equals $-B$).

Similarly vectors C and D of 150 and 200 units' length in directions 20° south of west and due south-east respectively, are represented by OS and OT (*not* by OY and OZ).

These four vectors would be written, for short, in accordance with the above:

A as $100_{40°}$, B as $50_{170°}$, C as $150_{200°}$, and D as $200_{315°}$.

54. Let us consider the motion of a boat travelling across a river. We will assume that the river (Fig. 33) flows due east—the width of the river is 50 yards—and

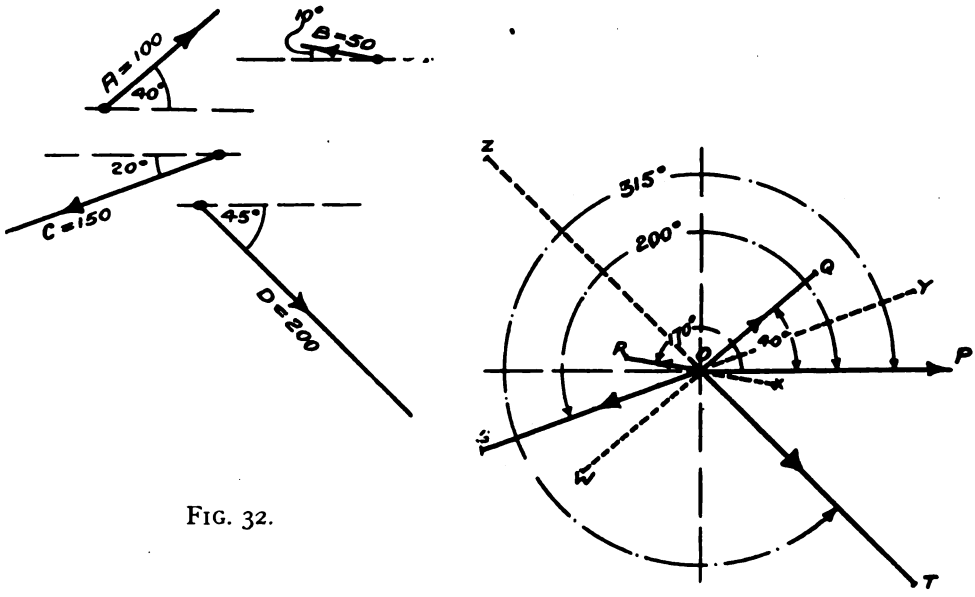

FIG. 32.

that the boat starts from the point, A, on the south bank. If it were not for the river current the boat would, assuming it is kept pointing due north, touch the farther bank at B, but owing to the current it actually touches at C.

We will suppose that the water has a stream velocity of 4 miles per hour, and that the boat is propelled at 8 miles per hour. Thus, for every yard the boat progresses *across* the river it will be carried half a yard *down* stream, and so the distance from B to C will be half the width of the river, or 25 yards.

55. If, now, we required to find the *actual velocity* of the boat—that is, the resulting velocity produced by the combination of the two velocities of 4 miles per hour and 8 miles per hour at right angles to one another, we could easily do so by the use of vectors.

We consider the boat as having two velocities impressed upon it simultaneously, and we then combine these two velocities to find the one *resultant* velocity which the boat actually acquires.

Using any convenient scale, say, 1 inch = 4 miles per hour, we draw XY (Fig. 34) 2 inch long, representing the 8 miles per hour velocity *across* the river; we then add to it YZ, 1 inch long, representing the 4 miles per hour velocity *down* the river. Then XZ

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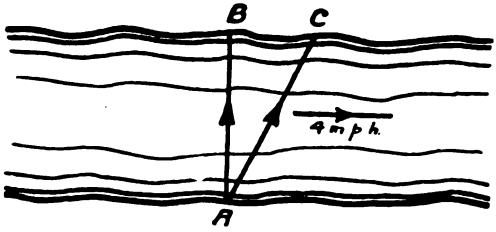

FIG. 33.

will give us, in magnitude and direction, the true velocity of the boat—in this case $2\frac{1}{4}$ inch (nearly) = 9 miles per hour.

Note particularly that we should have been hopelessly wrong if we had simply added or subtracted the two velocities *arithmetically*, thus getting either 12 or 4 miles per hour; we *must take direction into account* as well as magnitude.

In this particular case we need not have gone to the trouble of drawing the velocities to scale and measuring the resultant because, there being only the two velocities at right angles to one another, the resultant velocity is equal to

$$\sqrt{XY^2 + YZ^2} = \sqrt{(8)^2 + (4)^2} = \sqrt{64 + 16} = \sqrt{80} = 9 \text{ miles per hour (nearly).}$$

The advantage of our drawing and scaling method, however, will be more evident from the following example, in which we have to find the resultant of three velocities not at right angles to one another.

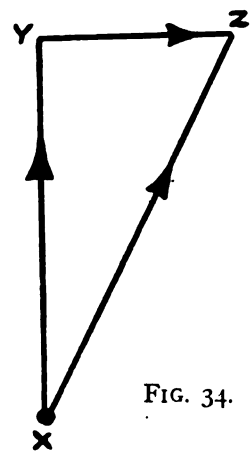

FIG. 34.

56. A boat, *A* (Fig. 35), is acted upon by three forces. Its own motive power would give it a speed of 10 miles per hour due north, the stream current a speed of 6 miles per hour 30° south of west, and the wind a speed of 3 miles per hour due south-east. The actual speed of the boat is, of course, obtained by compounding together these three speeds, $10_{90°}$, $6_{210°}$ and $3_{315°}$, as follows:

PQ (Fig. 36) represents the 10 miles per hour speed due to the boat's own motive power, *QR* the effect of the current, and *RS* the effect of the wind.

The actual speed is given in magnitude and direction by the vector, *PS*, and is 5·7 miles per hour in a direction $32\frac{1}{2}°$ west of north (or $57\frac{1}{2}°$ north of west).

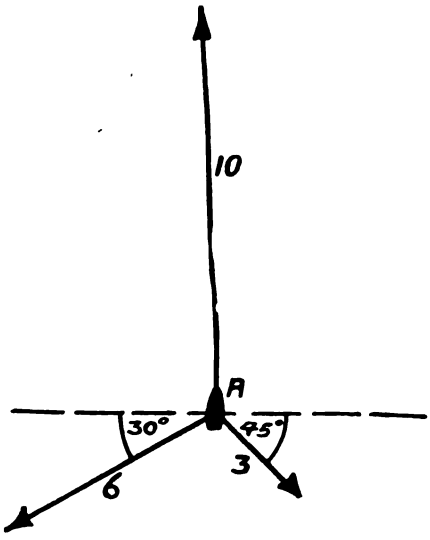

FIG. 35.

The above method would have been applicable had *A* been, say, a body acted upon by forces of 10, 6 and 3 lbs., or by accelerations of 10, 6 and 3 metres per sec. per sec., acting in the directions shown. In these cases *PS* would have given the resultant force or acceleration in pounds or metres per sec. per sec. respectively.

It is interesting to note that if the three vectors were forces, then a single extra applied force equal to *SP* or *minus PS* would neutralise the system, and so hold the body, *A*, stationary. (In this connection see also the last example in Article VII.)

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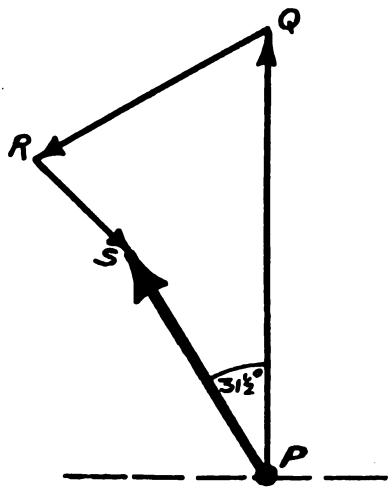

FIG. 36.

It will be quite easily understood that this process of addition of vectors is not limited to two or three, but can be used for the addition of any number of them.

57. The *subtraction* of vectors can be carried out in a similar manner, the only difference being that when subtracting a vector Y from a vector X $(X-Y)$ we must *reverse the direction* of the vector Y and *add* it to X. Fig. 37 shows the difference between $(X+Y)$ and $(X-Y)$.

58. Fig. 38 shows the addition of a vector *ab* to a vector *Oa*, the sum being the vector *Ob*. Now we should have arrived at the same result if we had set out *Od*, from *O*, equal and parallel to *ab*, and then completed the parallelogram *Oabd*, taking the diagonal *Ob* as the sum. If, again, a third vector, *bc*, had to be added, thus giving the resultant sum *Oc*, we should have got the same result by setting out *Oe* equal and parallel to *bc*, completing the parallelogram *Obce*, and taking the diagonal, *Oc*, as the sum.

We can thus sum any number of vectors by setting them out as radiating from one convenient point, completing a parallelogram with two of the vectors for adjacent sides, completing a second parallelogram with the diagonal of the first parallelogram and the third vector as adjacent sides, forming a third parallelogram with the diagonal of the second parallelogram, and the fourth vector as adjacent sides, and so on until all the vectors are added in.

Example.

A body is acted upon by three forces: 3 lbs.$_{60°}$; 2 lbs.$_{130°}$; and 7 lbs.$_{330°}$.

Find the resultant force on the body.

In Fig. 39 *Oa*, *Ob* and *Oc* represent the three respective forces to a force scale of 1 inch = 4 lbs.

Completing the parallelogram *Oadb* as shown, we get *Od* as the resultant of *Oa* and *Ob*. Next, completing the parallelogram *Odec*, we get *Oe* as the resultant of the three forces. By measurement *Oe* is 1·58 inch long, representing 6·3 lbs., and is at an angle of 5·7° from the horizontal.

Therefore the resultant force is 6·3 lbs.$_{5·7°}$. *Ans.*

59. The great drawback of this method of calculation is that the accuracy of the results obtained depends entirely upon the accuracy with which the drawings are made. Thus good drawing instruments are necessities for any but approximate results. We must therefore have at our command some method by which the results can be *calculated* instead of measured, and such a method is that of *Rectangular Components.*

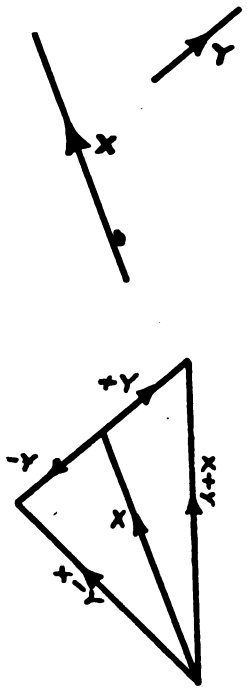

FIG. 37.

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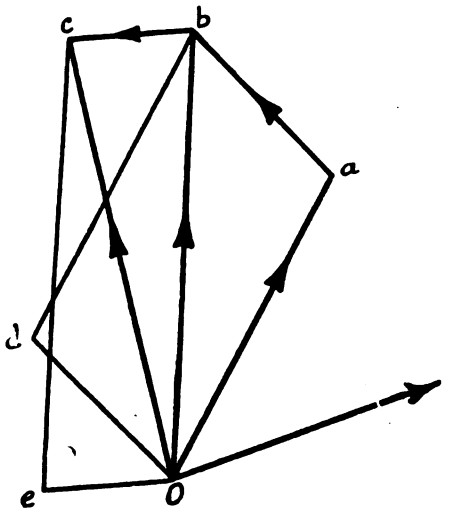

FIG. 38.

It will be remembered that the first example we had of a vector addition (see par. 54) was greatly simplified, and indeed the accurate drawing to scale was rendered unnecessary owing to the fact that the two vectors were at right angles to one another. The method of rectangular components utilises the properties of a right-angled triangle by splitting up each vector into two sets of components at right angles to each other.

Fig. 40 shows a simple case of two vectors, $OA = 7_{30°}$ and $OB = 5_{110°}$, the resultant of which is required.

Produce PO to Q as shown, and also draw ROS perpendicular to PQ.

Complete the parallelogram $OADB$, and OD, as already shown, will be the resultant we want to find.

From A, B and D draw AC, BE and DS perpendiculars on to RS, and also draw AP, BQ and DF perpendiculars on to PQ.

If, now, this figure be examined you will see that CO, being the perpendicular height of the vector OA, equals the perpendicular height of BD, and so $CO = ES$. Also OE is the perpendicular height of the vector OB.

But the perpendicular height of the resultant vector OD is :

$$OS = OE + ES = OE + OC$$

= sum of perpendicular heights of components.

Similarly, the horizontal space covered by resultant vector OD is :

$$OF = OP - PF$$
$$= OP + OQ$$

(agreeing that distances to the left of and below O shall be *negative*, and that therefore $PF = -OQ$).

Thus, the horizontal space covered by the resultant vector equals the sum of the horizontal spaces covered by the components.

We see from the above example that, if we can only split up our vectors into these components at right angles to one another, all we need do in order to find the resultant is to add up each lot of components separately, thus getting the two sides of a right-angled triangle, the hypotenuse of which will be the required resultant.

It only remains now to devise some means of finding mathematically the values of the two rectangular components of a vector, thus obviating the necessity of drawing and scaling off. This is quite a simple matter.

Referring to Fig. 40, we see that angle $POA = 30°$ and angle $POB = 110°$.

Also $OA = 7$ and $OB = 5$ units in length.

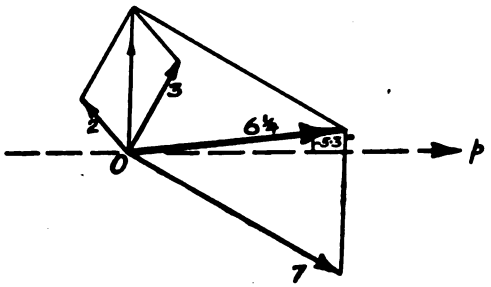

FIG. 39.

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Now $OC = AP = OA \times \sin 30°$
$= 7 \times \frac{1}{2} = 3{\cdot}5.$

Similarly $OE = BQ = OB \times \sin 110° = OB \times \sin 70° = 5 \times {\cdot}9397 = 4{\cdot}7.$

Therefore $OS = OC + OE$
$= 3{\cdot}5 + 4{\cdot}7$
$= 8{\cdot}2$ units.

Also $OP = OA \times \cos 30°$
$= 7 \times \frac{\sqrt{3}}{2} = 3{\cdot}5\sqrt{3} = 6{\cdot}06$

and $OQ = OB \times \cos 110° = OB \times (-\cos 70°)$
$= 5 \times (-{\cdot}3420) = -1{\cdot}6100.$

Therefore $OF = OP - PF = OP + OQ$
$= 6{\cdot}06 + (-1{\cdot}61)$
$= 4{\cdot}45.$

Proceeding, $OD^2 = OF^2 + FD^2$
$= OF^2 + OS^2$
$= (4{\cdot}45)^2 + (8{\cdot}2)^2$
$= 19{\cdot}85 + 67{\cdot}4 = 87{\cdot}25.$

Therefore $OD = \sqrt{87{\cdot}25} = 9{\cdot}33$ units long.

Also angle $POD = \tan^{-1} \frac{FD}{FO}$
$= \tan^{-1} \frac{8{\cdot}2}{4{\cdot}45}$
$= \tan^{-1} 1{\cdot}843$
$= 61{\cdot}5°$ (approx.).

Therefore OD, the resultant of OA and OB, is $9{\cdot}33_{61{\cdot}5°}$.

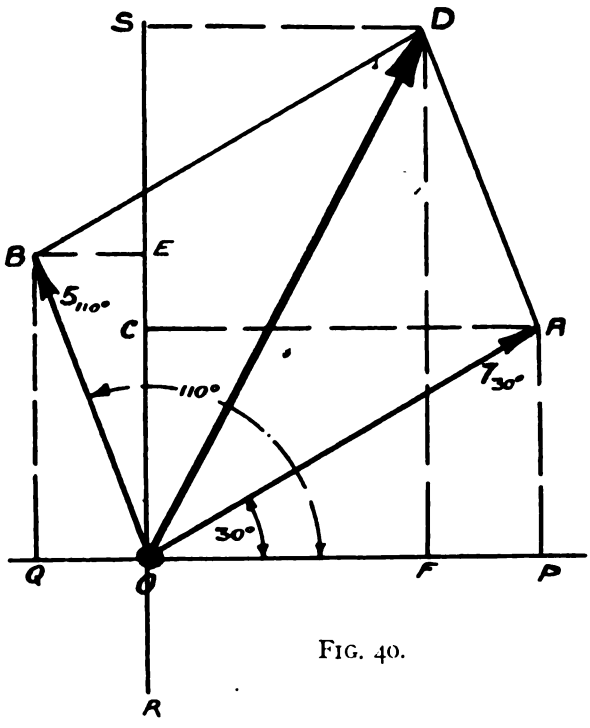

FIG. 40.

Most Unreasonable.

THE following little story which, unlike many wireless stories, happens to be true, reaches us from somewhere East of Suez: "I have heard it," says our correspondent, "from an 'ear-witness,' and have met Captain ——, who was for a while an officer of "the lines of communication in this field of operations. It should be remembered on "his behalf that our field stations are often given frequently-altered two-letter calls.

"Captain —— handed in at —— Station an important message marked 'urgent,' "but the operator on duty finding that atmospherics rendered transmission impossible, "returned the message to the sender with the following note, 'unable to transmit "'owing to XS.' This had the effect of bringing the gallant Captain to the station in "no gentle mood. 'What do you mean by not transmitting this urgent message? "'Who is this "XS"? Tell him to stand-by at once!'"

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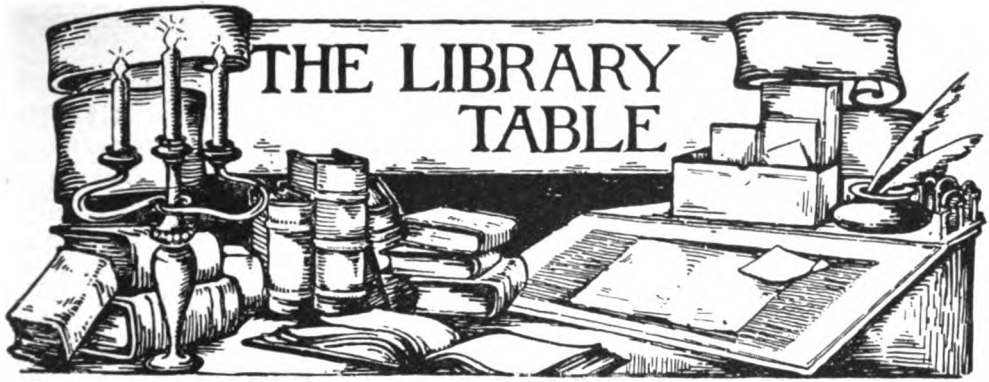

"CONTINUOUS AND ALTERNATING CURRENT MACHINERY PROBLEMS." By William T. Ryan. New York: John Wylie & Sons, Inc. London: Chapman & Hall, Ltd. 1915. 2s. 6d. net.

This little book of problems has been prepared to be used in conjunction with Morecroft's "Elementary Text Book of Continuous and Alternating Current Machinery," as text for a short course given by the author to civil and mining engineers.

General problems and mathematical formulæ often prove very uninviting to the student, and unless he is given ample opportunity for applying his knowledge to definite practical problems much of the instruction received in the technical school is apt to be quickly forgotten. The student who works out the problems contained in this volume will be well prepared for the practical work he will have to undertake upon joining the profession and will be able to forge ahead of those who have neglected practical application.

Although, as mentioned above, the book is primarily intended to be used in conjunction with a particular text-book, it will nevertheless be found suitable for use with practically any of the available text-books or with a lecture course.

* * * * * *

"THE BRITISH JOURNAL PHOTOGRAPHIC ALMANAC, 1916." London: Henry Greenwood & Co., Ltd. Paper covers, 1s. net; cloth, 2s. net.

This well-known volume, the contents of which fully justify the sub-title "Photographers' Daily Companion," appears this year as usual, although, of course, the number of advertisements is slightly smaller than in peace time.

The editor, in the preface, remarks that the past twelve months have naturally been a time of much embarrassment to those engaged in the manufacture of photographic apparatus. Lack of raw materials, deficiency in transport and shortage of labour are difficulties with which makers have had, and still have, to experience, and therefore it is a matter of congratulation that the disturbance of conditions, so far as concerns the production of plates and papers, has been as small as it is.

The first feature which strikes us in opening the volume is the valuable article entitled "Practical Notes on Printing Processes." In this the editor deals in a masterly fashion with all of the processes by which a photographic print is produced, incorporating many valuable hints to both the amateur and the professional. Following this article we find the "Obituary of the Year," "An Epitome of Progress," a chapter on "Apparatus

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and Equipment," and some useful notes on photographing of various subjects. Next we come to a section of notes and hints upon negative processes, printing processes and colour photography. Not the least important section of the book in war time is that entitled "British Resources in the Manufacture of Photographic Materials and Apparatus." This will serve to show buyers, large and small, in all parts of the globe, what British manufacturers can do, and how they can supply much of the material which, prior to the war, was purchased from enemy countries. We are glad to see that the regular feature, "Formulæ for the Principal Photographic Processes," is well up to standard and that the various "Tables" are as useful as ever. Altogether the editor and publishers are to be congratulated on producing such an excellent volume during such a trying time.

* * * * * *

"'LEKTRIK' LIGHTING CONNECTIONS: INTRODUCTORY AND EXPLANATORY NOTES." By W. Perren Maycock. London: A. P. Lundberg & Son. 6d. net; post free, 7d.

The "man-in-the-street" is apt to consider that the arrangement of electric lighting switches is a comparatively simple matter, and on taking a house where electric is being fitted rarely troubles to specify anything more than that a switch should be placed by the door in each room.

The little book under review sets out to show how easily adequate switching facilities can be provided in private houses, public offices and buildings. The writer, who is well known for his clearly written manuals on various electric subjects, commences by saying that the art of electric lighting is the combination of two other arts—namely, the art of illumination and the art of switching. If the switching of an installation is badly arranged half of the conveniences of the electric light system are lost and the quarterly bills of current are much greater than they need be.

The writer shows that the advantages gained by a scientifically arranged system of switching far outweigh the small additional cost, and we think that the value of the book will be clearly shown if we indicate briefly one or two of the specialised switching systems described therein.

In a private house of moderate size there are numerous places where small lights are needed, such as cellars, cupboards, dark corners, lofts, etc.; but, on the other hand, most householders do not care to have a large number of such lights, as they are liable to be left on and cause the lighting bill to mount at an alarming speed. Mr. Perren Maycock describes in this book some simple but nevertheless effective systems of "restrictive" lighting by means of which the wiring can be so arranged that all the lights cannot be burning at the same time, the switching on of one light requiring the extinction of another.

A further interesting section of the book is devoted to "Dim-Light Control," by means of which the light at various points can be "dimmed" without any additional apparatus beyond the switch and wiring. Thus a pair of lights in the bedroom can be switched in parallel where full light is required and in series when only a dim illumination is needed. In this way sufficient light can be given to night nurseries, hospital wards, etc., whilst the current consumption can be reduced to a minimum.

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Space will not permit us to mention more than one other feature of the book, this being the method of "Master-Switch Control." By this method a housekeeper or caretaker in a large building can switch all of the lights in the building on or off without troubling to visit the individual switches, and can also arrange his master-switch so that lights can be switched on or off at separate points as required. Very little additional wiring is required for this purpose, and we are sure that if the system were more widely known it would be most extensively used.

We think we have written enough to show how valuable this little book can be to the lighting engineer and to the intelligent householder who wishes to get maximum efficiency from his electrical lighting installation.

* * * * * *

"AEROPLANES AND AIRSHIPS." By W. E. Dommett. London: Whittaker & Co. 1s. net.

If any of our readers desire to invest a shilling in a volume dealing with the above topical subject, Mr. Dommett's book will afford him an excellent opportunity. The book has been written as a companion volume to the author's work on "Submarine Vessels," which ran through three editions in six months, and we anticipate that the present volume will be equally popular. The work is professedly written for the general reader who has little technical knowledge of the subject; but, as the writer claims, it contains sufficient technical matter to be of value to a reader having some engineering knowledge and desiring to apply it to the study of this branch of the subject.

After opening with an interesting chapter on the history of aircraft the author proceeds to discuss general principles, and the relation between structure and function of machines intended for aerial navigation. This is followed by descriptions of various types of finished machines. Among those discussed are the monoplane, a biplane scout, the Sikorsky biplane, a pusher biplane, a "gunbus"—as the battleplane is called by aeronauts—a seaplane, an arrowtype, and the German Taube, which "differs from other machines in that the planes in plan view resemble the wings of birds." We are informed that in this type "more extended attempts have been made to copy the bird than with any other, even to making the ribs flexible toward the rear or trailing edge, so that the cross-section flattens itself automatically to suit varying speed conditions." The author then proceeds to consider engines and propelling plant, steering and manœuvring apparatus, equilibrium and stability, and the gliding angle. A considerable amount of space is devoted to a description of what might be termed the military fittings of aircraft—guns, bombs, etc.—and there is even a chapter on the instruments and means for combating hostile aircraft, such as searchlights and anti aircraft guns. We are all the more surprised, therefore, to find no reference to wireless by the agency of which aerial navigation has been vastly increased in utility. Readers of THE WIRELESS WORLD will doubtless be familiar with this aspect of aviation through the valuable series of articles contributed by Mr. H. M. Dowsett under the title of "Some Special Problems of Aircraft Wireless." Possibly this side of the subject will receive attention in those future editions of this work of which the present issue gives ample promise.

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Personal Notes

CHIEF PETTY OFFICER CHARLTON.

Best wishes from THE WIRELESS WORLD to Chief Petty Officer Charlton, R.N.A.S., Wireless Section, who was married on February 7th, at West Ham, to Miss A. Q. Newell. Mr. Charlton, prior to joining the Forces, was a telegraphist in the service of the Marconi's Wireless Telegraph Co., Ltd., at Marconi House. We trust that the bride and bridegroom will have a long and very happy married life.

* * * *

The parents of Operator Baker, concerning whose sad death we wrote in our March issue, have received from the Chaplain and Staff of the General Hospital, Alexandria, expressions of the sincerest sympathy in their terrible bereavement. The late gentleman passed away very quietly and painlessly, and was cheerful up to the very end. He was a great favourite in the hospital and his cheery disposition endeared him to everyone.

* * * *

IT is with the deepest regret we have to report the news which has just reached us of the death of Mr. P. H. B. Saunders, who was killed at Loos on September 25th last. The late Mr. Saunders, who, prior to joining the London Irish, was an assistant in the Transfer Office of the Marconi's Wireless Telegraph Co., Ltd., had been in that Company's service for about five years. Always taking a keen part in the Marconi Athletic Club, he was very popular with the staff and the older members of the Company. We are sure that all of the late Mr. Saunders's associates and friends at Marconi House will join with us in tendering our deepest sympathy to the late gentleman's relatives.

* * * *

In our September issue we had the pleasure of announcing that Warrant

THE LATE P. H. B. SAUNDERS.

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WARRANT TELEGRAPHIST S. LEMON, R.N., LEAVING BUCKINGHAM PALACE, AFTER RECEIVING THE DISTINGUISHED SERVICE CROSS FROM THE KING.

Telegraphist Samuel Lemon, R.N., of H.M. patrol ship *Alsatian*, had been awarded the Distinguished Service Cross for meritorious work on the high seas. We are now able to reproduce a photograph of the gallant gentleman leaving Buckingham Palace after having the decoration conferred upon him by the King. We again offer him our congratulations.

* * * *

We regret to learn that Second Lieutenant Ralph Williams, late of the Accountant's Department at Marconi House, has been wounded at the front and is at present in hospital. Mr. Williams, who, previous to the War, belonged to the Civil Service Rifles, was called up for service on the outbreak of war and proceeded with his regiment to France. Early in this year he was offered and accepted a commission in the 8th Battalion, Royal Lancaster Regiment, and received his injury (a shattered arm) at the beginning of last month. We trust his recovery will be a speedy one.

* * * *

In the annual report of the Marconi Companies' Benevolent Fund we notice that 96 members are now serving with the Forces. The Committee regret to report the death of four members :

Warrant Telegraphist G. Turner (H.M.S. *Hogue*).

Warrant Telegraphist W. H. Silvester (H.M. Trawler *Colombia*).

Warrant Telegraphist J. Farmery (H.M. Wireless Station, Demerara).

Operator G. H. Dewey (s.s. *Persia*).

Notes concerning the late gentlemen have already appeared in THE WIRELESS WORLD. In each of the cases mentioned the relatives have received the Life Assurance payment provided for under the Marconi Companies' Pension Scheme.

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Patent Record.

WITH the opening of the New Year a new system of numbering patents came into force. Under this arrangement the number formerly given to both application and patent alike—*e.g.*, 23,456 of 1915—now becomes the serial application number which, on the acceptance of the complete specification or its becoming open to public inspection before acceptance, is superseded by a new number. This latter will be the patent number and is the one which should in all cases be employed when once given. To avoid confusion with previous numbers of other years these new patent numbers will start with No. 100,001, while the date will be, as formerly, either that of the filing of the English application or, under the Convention, that of the first foreign application.

In the following list the dates and numbers given are those of the applications; where patent numbers have superseded these they are given at the end of the description.

88. January 3rd. S. Salto. Apparatus for concentrating and projecting radiant energy.

139. January 4th. H. Smith. Transmitters, microphones, relays and the like for telephonic and similar purposes.

245, 246 and 247. January 6th. Marconi's Wireless Telegraph Co., Ltd., and George M. Wright. Receivers for wireless signals.

339. January 7th. W. J. Mellersh-Jackson (for A. Arbib). Radiotelegraphic apparatus.

372. January 8th. G. Constantinescu and W. Haddon. Transmission of energy.

417. January 10th. International Electric Co. and R. G. Lenoir. Telephone transmitters or microphones.

465. January 11th. British Thomson-Houston Co. and F. P. Whitaker. Electric rotary converters.

471. January 11th. Marconi's Wireless Telegraph Co., Ltd., and Charles S. Franklin. Electrical condensers.

599. January 13th. E. J. Close and C. F. Elwell. Radio receiving circuits.

681. January 15th. British Thomson-Houston Co. and P. C. Whitaker. Alternating current electrical apparatus.

731. January 21st. G. Marconi and Charles S. Franklin. Wireless telegraph transmitters.

732. January 21st. G. Marconi and William S. Entwistle. Wireless telegraph transmitters.

1097. January 24th. Marconi's Wireless Telegraph Co., Ltd., and Raymond D. Bangay. Lock nuts for aeroplane wireless installations.

1103. January 25th. B. Salarodi Borgo. Radio-active sighting device for use with firearms. (France, January 30th, 1915.) (Patent No. 100,050.)

1143. January 25th. F. N. Lanchester. Generator for electric oscillations or for alternating currents of high frequency.

1189. January 25th. Western Electric Co. and G. H. Nash. Telephonic receiving apparatus for aviators.

1481. January 31st. Emile Girardeau. Make and break switches. (France, January 29th, 1915.) (Patent No. 100,042.)

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Pastimes for Wireless Operators.

1.—THE BANJO.

By WM. S. PURSER.

A MAN may play a solo on a mouth-organ or a violin, but if he is an artist one should recognise the fact, and give him credit for it apart from any objections as to the type of musical instrument selected. In other words, it is preferable to listen to an artistic rendering of the "Spring Song" on the mouth-organ than to hear the same piece of music "murdered" by an incompetent player on the violin. For this reason I favour the banjo, and recommend it to those who were not fortunate enough to have been taught any other musical instrument in their school days, for it is fairly easy to learn, and one can become a creditable performer upon it in far less time than one can upon the violin or piano.

The comparative ease with which a degree of competency may be acquired on the banjo does not, however, reflect adversely upon the scope of the instrument, or the variety of effects which may be obtained on it, as I hope to show later on.

PORTABILITY AND CHEAPNESS.

The banjo is the traveller's, and therefore the wireless operator's, instrument *par excellence*. It is portable and light, and can be stowed away in any odd corner in its case without fear of being damaged. At a pinch, if much pressed for room, it may be hung upon a wall.

Another point, which will appeal to almost everybody, is the cheapness of the instrument, and all of its accessories and music. A good instrument may be obtained for a few pounds, which will last a lifetime with reasonable care, the tone improving with age. Balancing the cost against the number of hours' entertainment it will provide for yourself and, ultimately, your friends the cost becomes almost negligible. With such a hobby when in a foreign port, spending time with the banjo instead of spending money ashore, it may well be that the instrument will eventually save you money.

A good banjo will stand a lot of hard wear and tear, and apart from the vellum, which is easily and inexpensively renewed, will stand plenty of knocking about.

SOME POPULAR FALLACIES.

One of the popular fallacies regarding the banjo is that one has to have a black face and sing nigger songs. Nothing could be more absurd, and a visit to a good banjo concert, or listening to a good player, either personally or through the medium of the gramophone, will soon dispel the illusion. There is plenty of good banjo music to be obtained nowadays (in England), written by banjoists for the banjo, music that is unique in its way, and cannot be rendered properly on any other instrument—music which, by the way, sounds more difficult than it really is.

Some talk has been heard in the past of elevating the banjo, and playing classical music upon it, but I think that this is more likely to bring the banjo into ridicule

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than to improve its status. Plenty of people never play any classical music on the piano, and there is a very wide range for the banjo without classical pieces.

Apart from the several catalogues of music composed specially for the instrument, delightful in quality and tunefulness as it is, there is still a large field including most of the well-known songs, dances, marches, ragtimes, and other popular melodies of the day which may be easily rendered upon the banjo. To those who already know something of music and players of other instruments, who are thinking of taking up the banjo, I would mention that it has such a wide range of effects, varying from the shortest staccato to the longest sostenuto, and variations of quality of tone, light and shade, muting, harmonics, duo playing (air with self-accompaniment by one player on one instrument) as to astonish most people hearing the banjo moderately well played for the first time. The peculiar mellow, plaintive tone is particularly sweet and entrancing, while all the effects mentioned above, and others, may be readily obtained by the average player.

THE CORRECT METHOD OF HOLDING THE BANJO.

COMPANIONSHIP.

Generally speaking, the production of the banjo among a group of friends is most welcome, and the accomplishment of banjo playing adds to the popularity of the player. The banjo may almost be regarded as symbolical of good fellowship. There is also a bond of sympathy between one banjoist and another which tends to make everyone willing to lend a helping hand to a brother banjoist. There is no doubt that the banjo can be not only a boon companion, but the means of making lasting friendships. The portability of the instrument and the comparative ease with which a few tunes can soon be strummed make it, in many cases, the first friend of sea-going men and other situated in out-of-the-way places. In a foreign port, away from home and friend, with long evenings to pass away, the banjo steps in and helps one to wile away many an otherwise lonely hour. It is in such circumstances that the player fully realises that his instrument is a real and intimate companion.

Plodding away at difficult exercises and pieces days and evenings pass away in quick succession until one reaches home once more to find that the very means of overcoming loneliness and *ennui* has given you an art which is a delight to your friends

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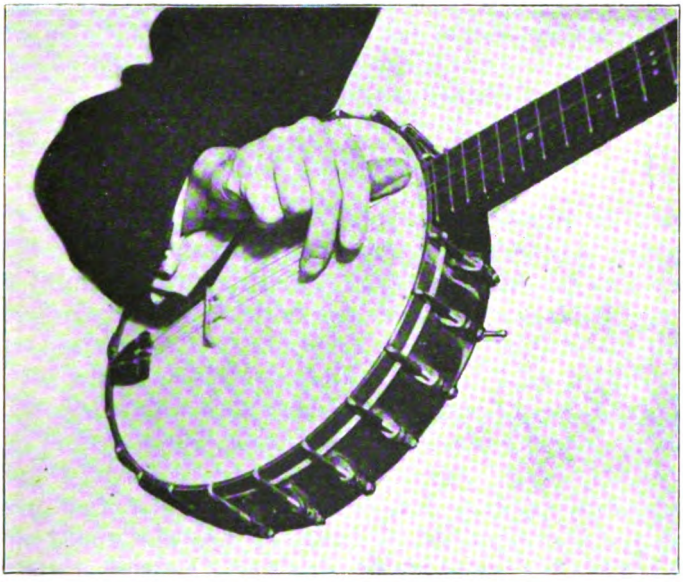
and saves you from being always the audience at any social gatherings, etc., you may happen to attend. Some people say the banjo is not a musical instrument—it is something more, more responsive than any other musical instrument, and, upon occasions, more lively than any companion.

Individuality.

By reason of the variety of musical effects obtainable on the banjo, it is particularly adapted to expressing the individuality of the player, as perhaps no other instrument. Mr. J. E. Vernham, in his "Harmonisation of Melodies," says: "The rules given and followed in harmonising these melodies, beyond being given as useful at this stage, are in no sense to be regarded as general rules in harmonisation, for, indeed, later on they must be frequently disregarded." Painters, writers, sculptors and musicians



METHOD OF PRODUCING TREMOLO, FOR USE IN SUSTAINED PASSAGES.

all have to follow certain standards and hard and fast rules when studying, but as they attain proficiency they must develop their own particular style and, leaving the narrow groove of convention, branch out into methods which show their own individuality. The banjo lends itself very readily to this, and just as the painter portrays his idea of some ancient historical event, or as the actor creates his part, so the banjoist creates his own rendering of the pieces he plays; and while playing correctly the notes written down, by variations of time, light and shade, and the hundred and one effects of which the banjo is capable, introduces his own individuality and temperament into the music to a remarkable degree.

Hints and Advice.

A few hints to intending beginners on the banjo may not be out of place, and if the advice given below is followed much doubting and dissatisfaction will be prevented.

When purchasing an instrument select a British-made *ordinary* banjo, and you

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will have a reliable article which will stand any climate. I would advise anyone buying a banjo to let the first cost be the last, and get a first-class instrument to start with. Not only are the results of your efforts far more encouraging on a good instrument, but there will be no need later on to feel that a better banjo is necessary, and sell the first at a loss. Do not be misguided by the expression, "Anything will do to learn on."

The banjo should have five strings. Banjos used to be made with six and seven strings, but these are out of date, and the only music now published is for the five-stringed banjo. Second-hand banjos with six or seven strings and such instruments converted into five-stringed banjos are all antiquated, and should be avoided.

Of the five-stringed banjos there are two kinds—the *ordinary* banjo and the *zither* banjo. The latter has wire strings, wooden rim and back, and, although not generally known, must be played with the finger nails (grown long) of the right hand in order to obtain the correct tone. This is in itself an objection, but a very real obstacle are the wire strings, which are apt to rust and break very quickly at sea. For these reasons the zither banjo is not to be recommended. If you do buy a zither banjo, however, avoid those with metal heads instead of vellum heads.

THE ORDINARY BANJO AND STRINGS.

The ordinary (or open-backed) banjo is the better instrument of the two, and on it alone can the real banjo tone be produced. For the best tone it should be strung with gut strings. As the thinnest strings (called the first and fifth) are difficult to obtain absolutely true in gut, imitation gut called "tropical" strings are generally employed. With these strings the true banjo tone will be obtained, and the player will generally be able to tell if a string is likely to break or require renewing from the frayed appearance of the gut after much wear. With wire strings no such warning is given, the strings having a nasty habit of going off with a snap in the middle of a solo.

The above remarks apply to four of the five strings of the banjo. The last is the bass string, and is made in two varieties—(1) fine wire wound on wire, (2) fine wire wound on silk. The latter should always be obtained, as the former is not sufficiently elastic. When striking a note on a "wire on wire" string the additional tension momentarily placed on the string by the act of striking produces a note of a slightly higher pitch than the note the string is tuned up to, and when playing loudly slight but perceptible variations in pitch are heard. In other words, there is a horrible twang. On the other hand, the "wire on silk" string is sufficiently elastic to prevent this happening, and emits only a pure note no matter how hard it is struck.

Wireless operators and others going on voyages or to out-of-the-way places should purchase strings by the dozen of each kind. Strings come cheaper by this method, also preventing the annoyance likely to be felt when a string breaks and there is no shop within a hundred miles where more may be purchased.

Having decided on your brand of strings, always get them from the same place, and you will not be disappointed. Generally it is wise to get strings from the banjo makers direct; they know the best kinds, and it is wonderful what a lot of difference to the tone an inferior string will make.

All spare strings should be kept in a tin box or leather case lined with oilskin, in order to protect them from damp or action of the sea air. If a gut string appears

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false when first placed on the instrument, take the string off and try it reversed. After gut strings have been exposed to the sea air for a long time on the instrument they gradually turn green. These should be then changed for new ones, as the tone will have become impaired.

The bridge occasionally gets displaced when travelling from place to place. In such cases it is useful to know that the 12th fret should be exactly midway between the ends of the playing portion of the string. The bridge should be adjusted accordingly. Bridges should be selected carefully, and any with metal, ivory, bone, or more than one kind of wood entering into their composition should be discarded. The thinner and more frail-looking the bridge the better.

The instrument should be kept in its case when not in use, especially in damp weather. The strings should *not* be let down after playing, but should be kept up to proper pitch continuously. The reason is that gut strings are elastic, and take some time to stretch properly. If let down and then tuned up some fifteen to thirty minutes' playing is necessary before they stop stretching, and continual tuning up is required. Nothing is gained by letting them down; on the other hand, the trouble mentioned is avoided by keeping them up to concert pitch all the time.

Teachers.

If any doubt exists as to which teacher to go to for lessons, it should be remembered that the best will be the least expensive in the long run, and give most satisfaction. A teacher, however little he may charge, cannot teach what he does not know.

A book called a Banjo Tutor, costing 1s. to 3s., will be required, the best giving photographs showing the correct method of holding the instrument and various positions of the fingers, etc., and are well worth the additional cost.

A few lessons from a first-class player will be better than years under a poor one. With the former you pay for experience which has taken years to acquire, and which is imparted to you in a few hours. You also have the satisfaction of getting on so much faster and the feeling that your knowledge is up to date. This is an advantage from a wireless operator's point of view, as he often has only a few days in port and no time for an extended course. I, personally, learnt more from a few lessons at wide intervals from a man in the first rank than I learnt in a dozen lessons in consecutive weeks from an average teacher.

When I speak of a few lessons, however, it must not be taken for granted that the banjo can be played well after a few hours. But anyone sticking at it for, say, an hour a day for six months would be able to play passably well, and beyond the exercise book stage.

WIRELESS WHISPERS.

All sorts of stories regarding wireless are "going the rounds" at the present time. The *Ladies' Pictorial*, under the heading printed above, gives the following tit-bit :—

"An officer patient on recovering consciousness after an anæsthetic, exclaimed, "'Look out, the English are tapping our wireless.' His name proved to be Teutonic, "and although he does not know it, he is now under close observation!"

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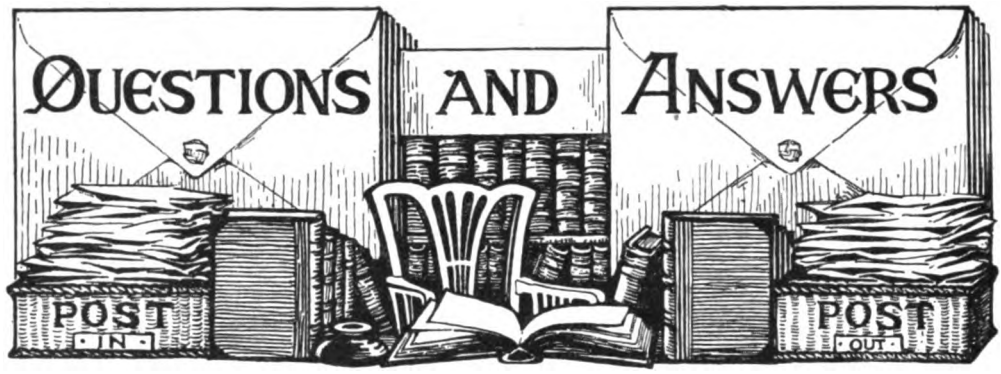

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study o the Editor, THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered : and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.*

L. G. (H.M. S. ——) asks : " Who were the two " operators on *Titanic* on her last voyage ? and, " on what ship did Jack Binns become well " known ? "

Answer.—The *Titanic* carried as operators : Jack Phillips, in charge, and Harold Bride, assistant. Jack Phillips lost his life at the post of duty, but Harold Bride was fortunately saved. In reply to the second query, Jack Binns became famous owing to his fine work on the White Star liner *Republic*, which collided with the s.s. *Florida* off the coast of the United States, on January 23rd, 1909. Binns succeeded in calling assistance by wireless with the result that all her passengers and crew were saved before the vessel sank. It may interest you to know that Mr. Binns is now on the staff of a famous New York newspaper and acted as war correspondent for that journal in Mexico. He was in Switzerland on his honeymoon when war broke out, and met with many exciting adventures whilst getting through to England in August, 1914.

J. A. M. (Auchterarder, N.B.).—Particulars of the Postmaster-General's examination are contained in the " Handbook for Wireless Tele- " graph Operators Working Installations Licensed " by His Majesty's Postmaster-General." This is obtainable from our publishers for 4½d. post free.

RADIO (Stranraer).—(1) The date on which it became compulsory for ship operators to possess the P.M.G. certificate was December 1st, 1908.

(2) We regret we are unable to furnish any information of this kind during the war.

(3) If you connect condensers in parallel with both the primary and secondary of your receiver you increase its wave length and hence long wave stations will be received better. There is no alteration in the coupling by this arrangement.

(4) If you receive a 600 metre wave from a station 7 miles away when tuned to Clifden or other long-wave station, your circuits must be very tightly coupled. The best coupling for such a case will usually be obtained when the primary is right out of the secondary owing to the large inductance of the coils which are in use. In this case, short waves will not jam nearly so much, and the long-wave stations should be more easily tuned and give better signals.

C. R. C. (Glasgow) asks why, when tuning a closed oscillatory circuit for the 300-metre wave, both the condenser and transformer are in series, whilst for the 600-metre wave both are in parallel. Is not the same energy obtained from the transformer in either arrangement ?

Answer.—The energy of a charged condenser is obtained from the formula : $E = \frac{1}{2} KV^2$ where K is the capacity of the condenser and V is the potential to which it is raised. When the two halves of the condenser are in series as for the 300-metre wave, the capacity of the combination is only a quarter of the capacity when the two halves are in parallel for the 600-metre wave.

In order to have the same energy for the two cases we must make the square of the voltage for the first case four times its value for the second case.

This will be the case if the voltage be doubled. Hence the two secondary coils are put in series so that the total voltage is twice that due to each half.

We have then :

$$E = \frac{1}{2} \frac{K}{4} (2V)^2 = \frac{1}{2} KV^2$$

or the same energy is obtained for both cases.

If the transformer were left in parallel then we should have for the 300-metre wave arrangement

$$E = \frac{1}{2} \frac{K}{4} V^2$$

which is a quarter of the other value.

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S. E. P. ? (Gosforth).—Apply giving full particulars as to training, etc., to the Traffic Manager, Marconi's Wireless Telegraph Co., Ltd. Marconi House, with reference to an appointment as Telegraphist at a land wireless station.

P. R. (Bannow) asks what is meant by the E.M.F. which is created in the secondary of an induction coil when the current is made in the primary.

Answer.—When a current is flowing in a coil of wire it creats a magnetic field through the coil. If, on the other hand, a coil of wire happens to be in a magnetic field, then an electromotive force will be developed in the coil when the magnetic field is varying in strength.

When the current in the primary of the induction coil is made a magnetic field is, therefore, created. Since the secondary coil is wound over the primary the magnetic field traverses the secondary, and since the field is varying in strength (from nothing when there is no current) an electromotive force must be developed in the coil.

2. Apply to the Traffic Manager, Marconi International Marine Communication Co., for particulars.

A. W. R. (Dartford) enquires with respect to a course of study to train as a wireless operator entirely by postal tuition.

Answer.—We are not aware of any course which would train you entirely by post, and in any case could not advise such an arrangement, as a practical knowledge of the apparatus can only be obtained by actually using it at a place where an installation is available. A postal course would be useful as regards the theoretical training, but it cannot completely take the place of the other.

For practice in reading wireless messages the Marconi records, an account of which appeared in the March issue would be of great service.

C. J. W. (Birmingham) enquires as to how far the formula $C = \frac{A}{4\pi t}$ can be relied on to give the capacity of a plate condenser, and states that, from experiments he has made, he is convinced that plates a foot square and $\frac{1}{8}$ inch apart have a capacity 10 per cent. to 20 per cent. greater than given by the above formula.

Answer.—The exact formula for a plate condenser has only been worked out for circular plates for which

$$C = \frac{\pi r^2}{4\pi d}\left(1 + \frac{d}{\pi r}\log_e \frac{16\pi r}{d}\right)$$

when the thickness of the plates themselves is neglected.

In the case quoted the ratio of distance apart to diameter, assuming the plates to be circular, is 1 to 96.

In Dr. Fleming's *Principles of Electric Wave Telegraphy*, page 176, it is shown that for a ratio of 1 to 100, which is nearly the same as above, the increase in capacity is about $2\frac{1}{2}$ per cent. only.

It must be remembered, however, that there is not only the capacity of the two plates, one to the other, to be considered, but the capacity of them jointly with reference to the earth, which in the case of a condenser of large surface area will often be large, depending on the distance of the condenser from the earth or objects at the same potential as the earth. This may easily account for the extra capacity mentioned.

M. C. L. (France) enquires whether there is any formula for earth resistance, expecially for the resistance of an earth system in 3 parts, *A*, *B*, and *C*, for which the resistance between each pair is known.

How is the constant in the formula

$$\lambda = 1885\sqrt{LC}$$ derived ?

Answer.—We shall be pleased to receive articles and photographs of French wireless work when you are able to send them after the war.

The formula for obtaining the resistance of an earth system which can be separated into 3 parts is given in Dr. Fleming's *Wireless Telegraphist's Pocket Book*, page 216.

Let S_1, S_2, S_3 be the resistances *between* the pairs *AB*, *BC*, *AC*, and let r_1, r_2, r_3, be the resistances *to earth* of the parts *A*, *B*, and *C* respectively.

Then $S_1 = r_1 + r_2$, $S_2 = r_2 + r_3$, $S_3 = r_1 + r_3$, by subtracting the first and second of these we get

$$S_1 - S_2 = r_1 - r_3$$

so that $S_1 - S_2 + S_3 = 2r_1$

Similarly

$$S_3 - S_1 + S_2 = 2r_3,\quad S_1 + S_2 - S_3 = 2r_2$$

so that the values r_1, r_2, r_3 can be calculated if S_1, S_2, S_3 are measured.

Then the resistance of all 3 plates in parallel is :

$$R = \frac{1}{\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3}}$$

[1] The formula for the wave-length of a circuit is

$$\lambda = 2\pi\sqrt{LC}$$

where the wave-length is in centimetres and L and *C* are in absolute electrostatic units or "centimetres."

As it is more convenient to work with wave-length in metres, inductance in microhenrys, and capacity in microfarads then, since

1 microhenry = 1000 centimetres
1 microfarad = 9×10^5 centimetres

we have, to reduce to these units

$$100\,\lambda = 2\pi\sqrt{L \times 1000}\sqrt{C \times 900000}$$
$$100\,\lambda = 2\pi\sqrt{L \times 10}\sqrt{C \times 9} \qquad \times 10 \times 1000$$
$$\lambda = 2\pi\sqrt{LC}\sqrt{9 \times 100}$$

which gives

$$\lambda = 1885\sqrt{LC}$$ for the usual units.

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A. C. Versailles (France) enquires: (*a*) Whether it is intended to issue an edition in French of the forthcoming *Year Book of Wireless Telegraphy*, and the postage on this volume to France.

(*b*) Also the formula for capacity inductance and wave-length of a receiving aerial, and the capacity of a tinfoil paper condenser.

(*c*) By what means can a receiving station be tuned to transmitting stations having very different wave-lengths from that of the receiving station? Is it necessary to increase the inductance or capacity?

Answer.—(*a*) It is not proposed to issue the forthcoming Year Book in French, as this would entail an amount of work which is impossible to undertake in the present circumstances. Perhaps in the more favourable future we may be able to carry out this suggestion.

(*b*) There is no difference in the formulas for the capacity inductance or wave-length of an aerial for receiving from those for a transmitting aerial. The best formulas for the capacity are those given in Professor Howe's articles in THE WIRELESS WORLD for December, 1914, and following numbers, for various types of aerials.

For the inductance of aerials the formula for a single wire is:

$$L = 2l\left(\log_e \frac{4l}{d} - 1\right)$$

where all dimensions are in centimetres and L is in "centimetres."

For multiple wire horizontal aerials formulas have been derived by Dr. L. Cohen, but are too long to quote here.

For the wave-length of an aerial of which the inductance and capacity are known, the formula

$$\lambda_m = 1200\sqrt{L_{mhy.}\, C_{mfd.}}$$

may be used.

The capacity of a condenser formed of tinfoil and paraffined paper is given by the formula

$$C = n\frac{kA}{4\pi t}$$

where k is the dielectric constant of the paper. A the area of 1 sheet of tinfoil, n the number of paper sheets between the foils and t the thickness of the paper.

If all dimensions be in centimetres the capacity will be given in "centimetres"

(*c*) To tune a receiving station to a longer wave-length it is necessary to add inductance in series with the aerial. To tune any closed oscillation circuit in the receiver (such as the circuit to which the detector is connected), either the capacity or inductance may be increased, in general it is best to increase the inductance.

We regret that owing to pressure on our space we have had to postpone the answers to several correspondents until next month.

SPECIAL NOTICE.

Readers are requested to note that save in exceptional circumstances we are unable to deal with queries through the post. 1517

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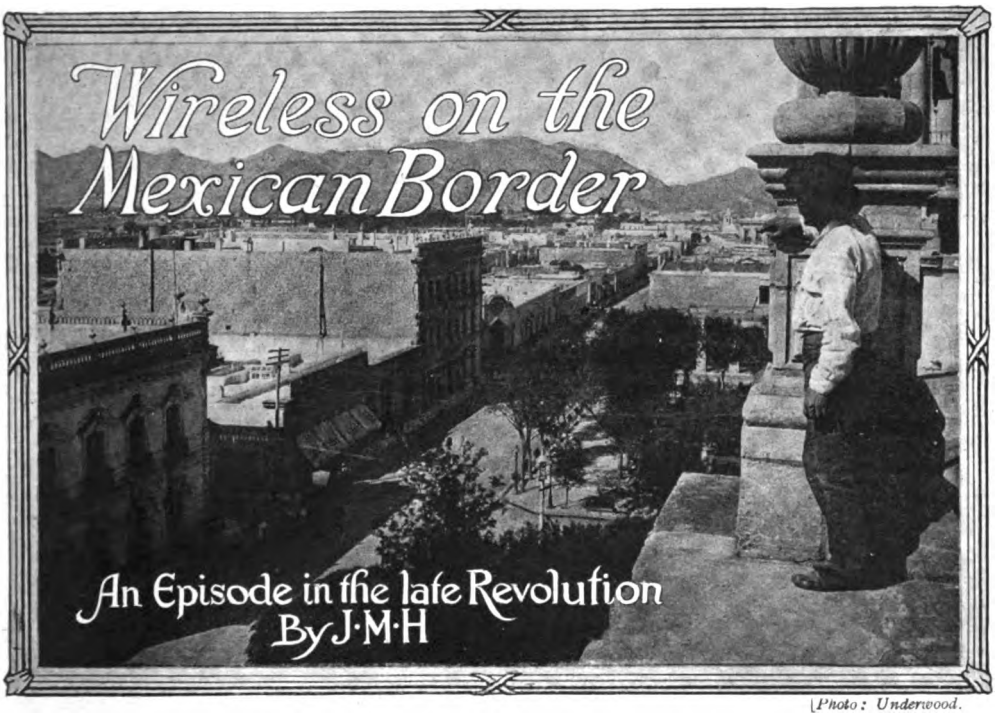

[Photo: Underwood.

VIEW OF CHIHUAHUA, THE MOST IMPORTANT CITY OF NORTHERN MEXICO, WHICH IN 1913 WAS DESERTED BY SALVADOR MERCADO, THE FEDERAL MILITARY GOVERNOR, WITH 3,000 TROOPS.

"ACROSS THE RIO GRANDE."—This phrase was the star of hope for those fugitives from justice in the United States of America thirty or forty years ago who, by crossing a narrow bridge spanning the river, entered another country, and were immune from the long arm of the law, as at that period extradition was not recognised in the turbulent republic of Mexico.

El Paso, in the United States, was the rendezvous for these desperadoes, who, when the sheriff was hot on their trail, had merely to run over the short wooden bridge separating the two countries and could from the Mexican side of the river hurl defiance at their pursuers. The city of El Paso is now a flourishing town, possessing many modern conveniences, and is an important railway junction.

A small percentage of the population consists of Mexicans, some of the better class owning considerable property, the remainder being of the labouring class, who reside in *adobe* (clay) houses near the bank of the river, whilst others work in El Paso and return to their homes in Mexico in the evening.

I was instructed to proceed from San Francisco, California, to El Paso, Texas, to take charge of the radio station. The apparatus had been partly installed, and the work consisted of tuning and getting ready for commercial business.

The border station formed the apex of an inverted triangle, the base being composed of the systems of other stations, and was situated some distance outside the city limits; the two lattice-work towers, which could be seen for miles, were three hundred feet in height, and the station, a one-storied three-roomed building, stood in a large plot of ground, on one side being the river, whilst at the other side and parallel to it

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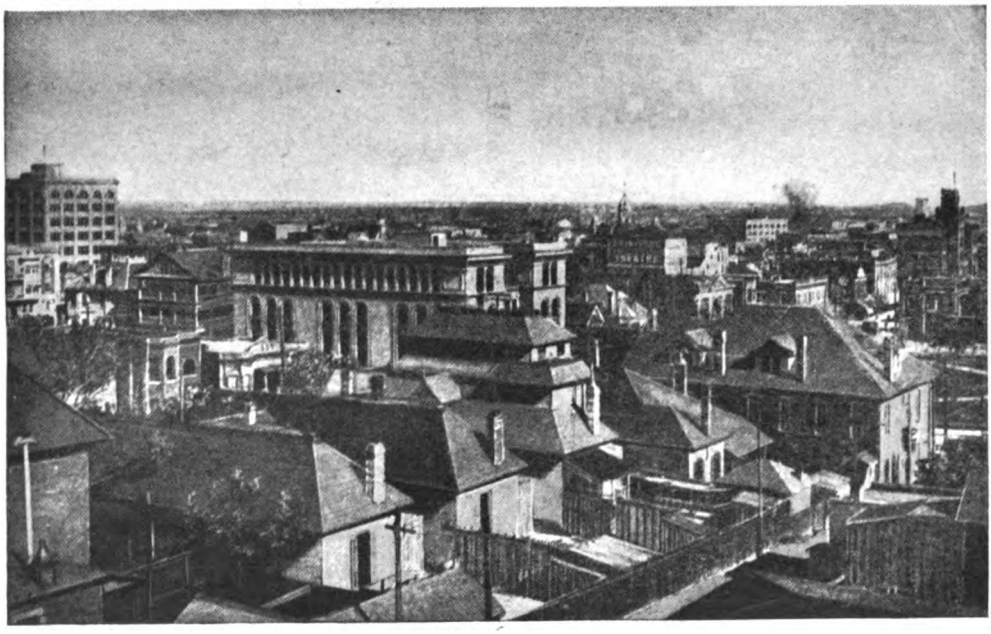
was an irrigation ditch. The residents on the other two sides were Chinese, who raised vegetables for the local market and had several Mexican labourers employed in tilling the ground. It was a frequent occurrence to hear voices in heated altercation punctuated by revolver shots, the Chinese landlords using the revolver to intimidate their Mexican employees.

The antenna was composed of phosphor-bronze wire, containing nearly 3,000 feet, and on one occasion, during a terrific storm of wind, rain and lightning, the entire aerial was blown down and hung a twisted and tangled mass of wreckage around the guy wires and towers. After the storm abated it was found necessary to go up aloft and with pliers clear away the fragments and make a new antenna. In order to protect the property on the station, one of the operators was always on the premises, and, as



BIRD'S-EYE VIEW OF EL PASO, TEXAS, LOOKING SOUTH.

I had chosen to stay there one night, retired about midnight, but was disturbed about five the next morning by the sound of musketry and machine-gun fire; this went on more or less all day and only ceased as darkness came on. At first it was thought the firing was caused by United States soldiers at target practice, but later on we learned that revolution had broken out and the rebels under General Madero were trying to overthrow the Government of Porfirio Diaz, and the border city of Juarez, close to El Paso, was the scene of severe house-to-house fighting between the rebels and Government troops. Several newspaper correspondents asked permission to be allowed to ascend to the top of the aerial towers, which was given, and accompanying them I had a splendid panoramic view of the Mexican battle. Uniformed Government soldiers and picturesquely attired rebels could be seen running hither and thither, and the bodies of those shot falling to the ground. Several days later one of the correspondents stated

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A STREET IN A VILLAGE IN THE NEIGHBOURHOOD OF THE UNITED STATES FRONTIER. NOTE THE PICTURESQUE COSTUME OF THE WOMAN IN THE FOREGROUND.

that there was to be a sensational event in the afternoon, saying that he had heard officially that one of the Government generals had been captured by the rebels and was held a prisoner. It appears that this military officer had ruled the civil population with extreme harshness, and now that they had him at their mercy the rebels plotted to surround the house wherein he was imprisoned, take him out and either hang or shoot him. An intimation of this plot was conveyed to Señor Madero, provisional president, who, being of very humane principles, determined to save the Federal officer from the angry mob of rebel soldiers.

It was arranged that during the noon siesta, when all the people go to sleep after

[*Photo : D. W. Hoffman.*

MEXICAN REVOLUTIONARY SOLDIERS SERVING UNDER THE REBEL LEADER, GENERAL VILLA.

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MEXICAN SCENERY NEAR THE CITY OF JUAREZ. THIS VIEW GIVES A VERY GOOD IDEA OF THE COUNTRY WHICH THE UNITED STATES ARMY HAS TO TRAVERSE IN ITS ATTEMPT TO ROUND UP THE REBELS.

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the usual late breakfast, a horse would be in readiness for the prisoner, his freedom given him, and he was told to ride along the bank of the river for four miles and then cross the narrow ford to the American side, where an automobile would be in readiness to rush him to a safe zone. Only a few of Madero's trusted officers were in the secret. After breakfast we ascended again to the top of the aerial towers, and through binoculars could see every detail of the little Mexican city. Bathed in brilliant sunshine, not much activity was noticed, and comparative silence reigned, when suddenly a loud clamour was heard of many voices, and through the field glasses we noticed a mob of Mexicans, with their curious conical-shaped straw hats, making for a certain point of the town towards the bank of the river, where a plantation ran parallel to it for a long way. Scanning the landscape we noticed, at a distance of about three-quarters of a mile, a figure on a white horse emerge from the forest screen and gallop at headlong speed along the road, followed by the yelling mob of half-crazed Mexicans. The picture was certainly dramatic in the extreme, and was a real race for life. Many shots were fired, and one seemed to strike the horse on the flank, causing it to swerve to one side, but the rider kept his seat, occasionally turning his head to look at his pursuers, who seemed to be handicapped by being unable to get over the uneven road at any speed.

When the horseman arrived at the prearranged spot on the bank of the river he turned sharply and forced his horse into the shallow stream. The bullets of his pursuers began to scatter the water around him, but the horse clambered up the opposite bank apparently unscathed. A large grey automobile appeared, and the general, jumping off his horse, entered the car and was whisked away sooner than it takes to write.

The newspaper men descended and wrote lengthy accounts of the occurrence, which were despatched by wireless to various parts of the United States.

When the Madero forces were in complete control of the northern part of Mexico it was the custom for residents of El Paso and tourists from other parts of the United States to visit the city of Juarez and look at the damage done to the houses by rifle and machine-gun fire and the Mexican followers of Madero always treated the foreigners with the greatest courtesy, and willingly showed them places of interest in the ancient historical border city.

America and the Allies

There have been many indications that our Transatlantic cousins are fully in sympathy with the Allies, and although officially the United States is neutral, much points to the fact that the average American is decidedly pro-ally. Marconi's Wireless Telegraph Co., Ltd., have received from a shareholder in one of the Western States the following letter :—

" Having received my Marconi cheque a short time ago, I hereby enclose it and " wish you to forward it to the Red Cross Fund for the Army, if it be no trouble to you. " I deeply sympathise with you in this war, and hope you will win out in the end."

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PERSONALITIES IN THE WIRELESS WORLD

[*Photo: Topical Press.*

MR. FREDERICK KOLSTER

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PROGRESS in radiotelegraphy owes much to the genius and investigations of scientists in the United States, where, happily for our Transatlantic friends, wireless research is unhampered by Government restrictions and the Defence of the Realm Act. Prominent in the ranks of American scientists interested in wireless telegraphy is Frederick A. Kolster, whose portrait we have pleasure in presenting to our readers on the opposite page.

Mr. Kolster, Radio Physicist of the Department of Commerce, Bureau of Standards, Washington, is of Swiss birth, and was brought by his parents to the United States of America thirty-three years ago while still an infant. His work in connection with radio-telegraphic matters is well known on both sides of the Atlantic, and many original papers contributed by him to the literature of wireless telegraphy have proved of the greatest use to investigators the world over. As an inventor Mr. Kolster has already distinguished himself by producing the "Kolster Direct-Reading Decremeter," an instrument largely used by the United States Government, and of the greatest utility and efficiency. A description of this interesting invention is to be found in the "Scientific Papers of the Bureau of Standards," Nr. 235.

Taking a prominent part in the activities of the well-known Institute of Radio Engineers, Mr. Kolster figures in the list of members and on the Committee of Standardisation. Wireless investigators and experimenters will watch with interest the career of this young scientist, who, at thirty-four, has already brought himself into such prominence.

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The Methods Employed for the Wireless Communication of Speech (ii)

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institution of Electrical Engineers, on February 2nd, 1916.)

The Arc Methods of Generating Oscillations.

If we take an ordinary continuous current arc and, while maintaining the arc length constant, we vary the current passing through it, and at the same time measure the P.D. between its terminals, we obtain what is called the characteristic of the arc. In the case of all ordinary arc discharges, this characteristic is what is called a " falling " or " negative " one, that is to say, when the current is increased the voltage falls, and *vice versa*.

Hence, if we connect across such an arc an oscillation circuit containing a condenser, there will be a sudden rush of current into the condenser tending to charge it : this current rush will momentarily cause a decrease in the arc current with, as a result, a corresponding rise of the P.D. across the arc terminals. This voltage rise tends to further charge the condenser to a voltage *above* the normal running voltage of the arc. As soon, therefore, as the charging current of the condenser begins to fall off the arc current will rise again to its normal value, accompanied by a fall of P.D. across its terminals.

We have now the condenser charged to a higher voltage than that across the arc, and as a consequence it immediately begins to discharge back through the arc.

This discharge current is in the same direction through the arc as the supply current, and hence causes a fall in the arc P.D. by reason of the increased current. This further facilitates the condenser discharge. As the condenser completes its discharge, the arc current falls and the P.D. rises again to their normal values, when the cycle is repeated over again and continues indefinitely as long as the supply is maintained and the arc retained of a constant length.

Hence the condenser will be continuously charged and discharged at regular intervals, depending on the inductance in the circuit, the capacity of the condenser, and the length and other conditions of the arc—in other words, continuous oscillations will be set up in the circuit by virtue of this action of the arc.

Looking at the production of oscillations in this way, we can at once see that the strength of the oscillations set up in the shunt oscillation circuit depends on the " steepness " of the arc characteristic, since, if we have an arc with a steeper characteristic curve, a given change in the current through the arc will give rise to a greater variation of the voltage at the arc terminals than it would under similar conditions with a " flatter " characteristic, or, in other words, greater charges will be im-

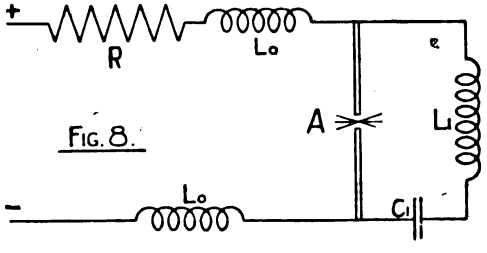

FIG. 8.

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parted to the condenser in each cycle, with a correspondingly greater amplitude of the discharge current—*i.e.*, more energy will be imparted to the oscillation circuit, and the oscillations will be consequently vigorous. Hence, it is easier to make an arc with a steep characteristic oscillate than it is one with a flatter curve; and as it is always more difficult to make an arc generate high frequency oscillations than it is low frequency ones, it follows that we require an arc which has a very steep characteristic in order to produce oscillations of wireless frequencies with any degree of readiness. By inspection of the characteristics, we see that they become much steeper for small arc currents, while at the same time for a given current a longer arc at higher voltage has a steeper characteristic, and hence in general low current arcs oscillate better than heavy current arcs—in fact, it is found, as soon as one begins to experiment with such arcs, that there are certain fairly well-defined current limits and arc lengths within which it is necessary to keep if oscillations are to be set up at all. The exact values of the current limits depend entirely on the type of arc and carbons, its length and conditions of use, and also on the values of the capacity and inductance in the shunt circuit.

As a rough guide for experimental purposes it will generally be found necessary to limit the supply current value to not more than about 2 or 3 amperes when employing arcs in air between ordinary solid arc lamp carbons, if it is desired to generate oscillations approaching wireless frequencies. With lower frequencies the supply currents may be increased. The arc length must, moreover, be kept very short. On the other hand, if very high frequencies are desired for experimental purposes, it will be generally found advantageous to employ special carbons for the arcs. Some grades of graphite rods are very suitable for this purpose, while the employment of compressed air or other gases round the arc often leads to considerable advantages from the point of view of the steadiness of the oscillations that are produced, as well as their intensity. The ratio of the capacity to the inductance in the oscillation circuit is also very important; a rough guide to begin with may be taken as ratio of inductance to capacity=about 100, when both are measured in absolute units (centimetres). This figure is, however, liable to very considerable variations to obtain the best effects, depending on the arc employed, on the supply voltage, and current, and more especially on the gas surrounding the are. The use of a suitable choking inductance in the supply circuit to the arc is also important to secure more vigorous oscillations by confining them to the oscillation circuit and preventing them going back on to the supply mains. From the above it is evident that, as the allowable current through the arc is limited in order to secure efficient generation of the oscillations, it is essential to employ high voltages if any considerable oscillatory energy is required. These results are best obtained by connecting a number of arcs in series, and running them off a high voltage supply circuit, with a common oscillation circuit connected across all the arcs. This method has been employed from time to time by various manufacturers in attempts to produce a commercial form of apparatus suitable for the generation of powerful oscillations.

THE POULSEN ARC.

About 1902 V. Poulsen discovered that if an arc were set up in an atmosphere of hydrogen or coal gas instead of air its characteristic was much steeper than that of the same arc burning in air, hence he employed such an arc in an atmosphere of hydrogen as a generator of continuous oscillations of wireless frequencies. It was also found

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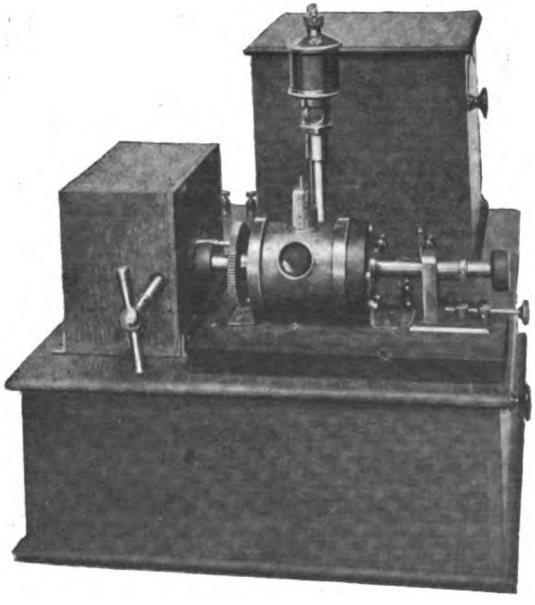
that the use of a water-cooled copper anode with a carbon cathode for the arc when used in the hydrogen or coal-gas atmosphere, referred to above, resulted in the production of steadier and stronger oscillations; while the employment of a transverse magnetic field across the arc was also claimed in his patents as additional means of ensuring steady and vigorous oscillations.* These features form the essentials of all the Poulsen arc apparatus, although, as is only natural, a number of improvements and alterations have been carried out from time to time in the commercial development of the apparatus.

The use of the electromagnets in the Poulsen apparatus was with the object of maintaining the arc in a definite position on the electrodes, and of a definite shape and length, and thus served to render the arc more regular and the oscillations more stable. It is possible also to so arrange a radial magnetic field in the neighbourhood of the arc that the arc keeps moving round the edge of the electrodes, thus bringing fresh electrode surface into play, and maintaining the arc at a more constant length by promoting a more regular wear of the electrodes. By this means it is possible to dispense with the necessity of rotating one of the electrodes (generally the carbon) that is otherwise necessary to ensure even wear of the electrode and regularity of the arc.

It has also been suggested, however, that the use of the powerful magnetic fields customary in the Poulsen apparatus has a greater utility than that of causing a mere steadying of the arc; and that the strong field really causes vibrations or oscillations to be set up in the arc, after the manner of arc interrupters, the arc being actually blown out by the magnetic field in some cases, and then automatically restruck again by reason of the applied voltage being sufficient to jump the small ionised space between the electrodes. Some such action as this may possibly take place in the Poulsen apparatus, as with suitable design it is found possible to increase the allowable current passing through one arc from a few amperes, which is all that is possible when operating in air with no magnetic field, to 25 or more amperes when used in the commercial Poulsen apparatus. This leads to a considerably increased output from the arcs.† The conditions which determine the production of oscillations of maximum intensity from arcs, from the point of view of the influence of the supply voltage, current, shunt capacity, frequency of oscillations, etc., have been studied by a number of



AN ARC GENERATOR USED FOR WIRELESS TELEPHONE TRANSMISSION.

* See V. Poulsen, British Patent No. 15599, 1903.

† See, for example, De le Rive, *Pogg. Ann.*, 76, p. 281 (1849); Ruhmer, *Electrotechnische Zeitschrift*, 26, p. 382; Kosler, *Electrotechnische Zeitschrift*, 28, p. 142 (1907); Hahnemann, *Electrotechnische Zeitschrift*, 28, p. 353.

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different experimenters. Reference may here be made, for example, to a paper by F. Mercer recently read before the Physical Society of London * on this subject. His conclusions may be summarised as follows :

" 1. There is a definite value of inductance for any given capacity which gives a " maximum current in the shunt circuit.

" 2. The effect of increasing the gas pressure becomes more marked as the electric " pressure is increased, but as the gas pressure rises the steadiness of the arc diminishes. " The effect is somewhat similar to that obtained by increasing the arc length.

" 3. Any effort made to increase the output by the use of a magnetic field, or by " altering the arc length, or the resistance in series with the arc, is detrimental to the " steadiness of operation."

These conclusions were of necessity obtained from the consideration of a limited number of experiments made on one type of arc (the copper-carbon arc in air), and therefore cannot be applied to any and every type of arc oscillation generator without modification.

Dr. Fleming's " Oil-Arc."

A recent development of the Poulsen arc apparatus enclosed in an atmosphere of hydrogen is one that has been carried out at University College, London, under Dr. Fleming, with the idea of dispensing with the cumbersome electromagnets required to produce the magnetic fields used in the Poulsen and other similar apparatus, and also of the necessity of providing a continual supply of hydrogen or coal gas.

Moretti has recommended the employment of an arc in an atmosphere of water vapour,† while in many other forms alcohol or methylated spirit vapour has been used to provide a hydrocarbon atmosphere to obtain an arc with a steep characteristic suitable for generating powerful oscillations.

In the oil-arc a number of arcs between carbon and copper electrodes are struck just over the surface of a heavy oil. The heat generated by the arcs causes vaporisation of the oil, and consequently an atmosphere of hydrocarbon vapour is created round the arcs.

No magnetic field is employed, and the oil generally provides sufficient cooling without having to resort to water cooling, but a water circulation through the oil may be provided if desired. The arrangement mentioned has been at present constructed for handling powers up to a maximum of about 2 kw. ; but it is probable that modifications would have to be introduced to enable it to be available for much higher powers. In connection with the operation of arcs of this type—*i.e.*, copper carbon arcs—it is interesting to note that it is not essential that the copper electrode should be positive, and the carbon negative, as is usually supposed,‡ and as is customarily the case, for example, with the Poulsen arcs, as advantages are often found in using the reverse connection. This is often more especially the case when difficulty has been experienced in starting up the arc and obtaining stable oscillations. Under these conditions a reversal of polarity will frequently cause strong oscillations to be set up, which persist when the polarity is again reversed back to the normal direction. The normal direction, copper positive, generally gives oscillations of more constant frequency than those obtainable if the polarity is maintained in the reverse direction.

* *Proc. Phys. Soc. Lond.*, 26, p. 372, June, 1914.

† See *Science Abstracts*, 16 B., No. 879.

‡ See, for example, *Barecca, the Electrician*, 60, p. 522.

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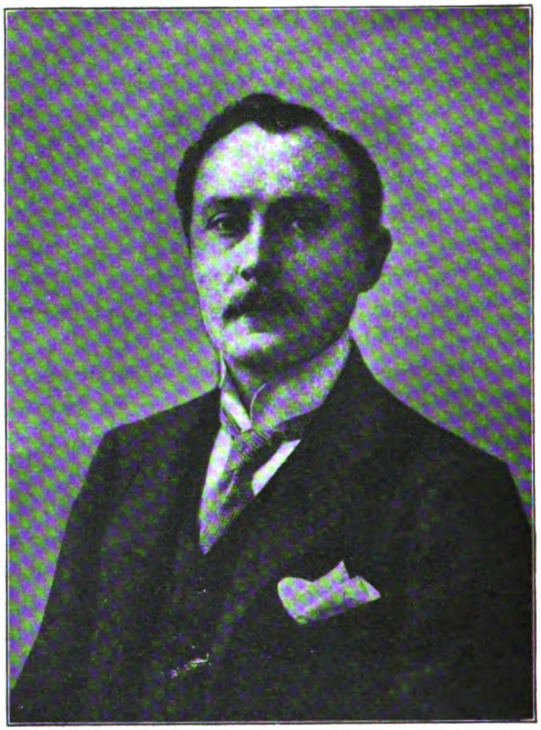
When an arc is running in air there is always a burning away of the carbons; if, however, the arc is placed in an atmosphere which is rich in carbon (hydrocarbon gases), the gas will be decomposed by the heat of the discharge, and carbon deposited on the arc electrodes. It is thus possible to have an arc in which the carbons "grow" instead of wearing away when in use. This is the case to a slight extent with the "oil-arc" described above, as when it is in use practically the only adjustments that are generally necessary (after the preliminary striking) are occasional movements of the electrodes further apart to compensate for the slight lengthening of the carbon rod.



[*Photo: C. Vandyck*

W. DUDDELL, F.R.S., WHO HAS CARRIED OUT MANY IMPORTANT INVESTIGATIONS WITH THE ARC, AND TO WHOM WE OWE MUCH OF OUR KNOWLEDGE OF SUCH OSCILLATORS.

It is obvious, however, that if the carbons wear away in some gases and grow in others, there must be some gas or mixture of gases in which these effects will exactly balance one another, and no adjustments of the arc should be necessary once the initial starting has been accomplished.

One such mixture is of acetylene and hydrogen (of which the relative proportions are best found by experiment). This mixture has been successfully employed in the Colin and Jeance apparatus, which will be described more fully below.

The same result could in all probability be achieved in the oil-arc (and similar apparatus) by the use of suitable liquids, or mixtures, instead of the oil at present employed.

THE COLIN-JEANCE ARC GENERATOR.

This arrangement, originally patented in 1909,* is in the main very similar to the Poulsen apparatus, in that it consists of three copper-carbon arcs connected in series, and burning in an atmosphere composed of a mixture of acetylene and hydrogen in such proportion that the normal wear of the carbon electrode is compensated for by the deposition of carbon from the gaseous atmosphere. The mixture of gases may be conveniently generated from mixture of calcium carbide and calcium hydride.

The usual supply voltage varies between 500 and 750 volts. The Colin-Jeance patent, referred to above, is, as far as I am aware, the first instance of the employment of an intermediate circuit tuned to the oscillation frequency for coupling the arc-

* British Patent, 18436, 1909.

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shunt circuit on to the aerial circuit. This arrangement is often employed now in this and other apparatus as it enables better tuning to be obtained and a purer wave radiated. On the other hand, the majority of arcs produce oscillations which are seldom of constant frequency, so that under these conditions it is generally found that the aerial current is not of by any means constant strength, because if the arc frequency varies it quickly falls out of tune with the aerial circuit, and therefore the current in that circuit quickly falls off. The presence of the intermediate circuit aggravates this trouble, since it renders the relative tuning of the arc circuits and the aerial circuits much sharper. On the other hand, since the intermediate circuit enables a purer wave to be radiated it enables sharper tuning to be employed at the receiver, thus minimising interference from other stations and also from atmospheric disturbances since the coupling can then be weakened.

It may be as well to mention here (as it was omitted in the preliminary discussion of the arc methods of producing oscillations) that the frequency of the oscillations in the shunt oscillation circuit across the arc does not depend merely on the values of the inductance and capacity in that circuit, as it does in the case of the majority of spark transmitters, and in the cases of oscillations in closed metallic circuits. This is on account of the fact that the resistance of the arcs is not negligible as it is in the majority of the other cases. Moreover, the effective resistance of the arc varies very considerably with the arc length and arc current, as shown by the characteristic curves previously shown.

The complete expression for the oscillation frequency in a circuit containing Inductance, L henrys; capacity, C farads; and resistance, R ohms, is

$$n=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$$

and it is therefore only when R is negligible compared with L that the frequency is given by the simpler formula $n=\frac{1}{2\pi}\sqrt{CL}$, which is the one most commonly employed. In this case n is a function of the arc length, etc.

To meet this case a formula has been devised by G. Nasmyth,* and is as follows:

$$n=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{\left(R-\frac{c+ld}{A}\right)^2}{4L^2}}$$

Where n is the frequency L is the inductance in henrys, C is the capacity in farads, R is the resistance in the oscillation circuit in ohms, A is the current through the arc, l is the length of the arc, and c and d are constants depending on the nature of the arc electrodes, and on the nature of the gas surrounding the arc.

Hence it is evident that quite small changes in the arc length supply current, etc., will produce changes in the frequency of the oscillations. This variable frequency is one of the great drawbacks to most arc transmitters, and renders their successful operation for prolonged periods a matter of some difficulty.

The Dubilier Arc Generator.

This apparatus is similar in general outline to the ones previously described, with the exception that attempts have been made to render the apparatus as a whole

* *Physical Review*, 27, p. 117, 1908.

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more portable, at least for the smaller powers. The arc is arranged to take place inside a closed copper cylinder, provided with means for adjusting the internal carbon electrode which forms the other arc terminal from outside the cylinder. The cylinder is generally fitted with radiating flanges to assist cooling. This arrangement usually renders water cooling unnecessary. A hydrocarbon atmosphere is employed, produced by the vaporisation of alcohol or methylated spirit, which is allowed to drip into the arc chamber when required, while a safety valve maintains the gas pressure approximately constant.

THE T.Y.K. ARC.

An interesting development of the arc oscillation generators has been made recently by some Japanese investigators, and is known as the "T.Y.K." system, from the initials of its inventors, W. Torikata, E. Yokoyama, and R. Kitsmura.* Its chief novelty lies in the materials used for the arc electrodes. These are made up from a pair of such substances as the following:

Silicon, ferro-silicon, carborundum, boron, magnetite, iron pyrites, molybdenite, etc. The combination of magnetite and brass is said to give on the whole the most satisfactory results. A continuous current supply at about 500 volts is usually employed. It would appear that this apparatus is merely another particular case of what is apparently an oscillating arc, but really seems to be a quenched short spark operating at the usual arc voltages. Further details of such effects will be given below, see pp. 25 and 26.

A curious point in connection with these oscillation generators is that the materials employed for the electrodes are also capable of acting as rectifiers of alternating currents, and, in fact, of forming wireless detectors. For instance, it has been shown by Dr. Eccles† that ordinary crystal contact wireless detectors can be utilised to set up electrical oscillations of feeble intensity in a suitable oscillation circuit connected across them. This T.Y.K. apparatus therefore seems to correspond to some such action as this, but on a much more powerful scale.

(*To be continued.*)

Australian Wireless Corps

Recruits being urgently needed for the formation of a wireless corps for active service abroad, the matter was taken up by the Amalgamated Wireless (Australasia), Limited, and it is highly satisfactory to state that on the operators attending the school being informed of the urgency of the request, fifteen experienced telegraphists who are now going through a course of wireless at the Marconi School, 97 Clarence Street, Sydney, willingly marched to the Town Hall recruiting depot, and only one failed to pass the eye test of the recruiting officer.

This patriotic response should go a long way towards inducing others to enlist promptly.

* British Patent, 10823, 1912.

† W. H. Eccles, *The Electrician*, 72, p. 1058, *ibid.* 66, p. 384, etc.

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Digest of Wireless Literature

Wireless Transmission Problems.

At a recent meeting of the New York Electrical Society, held at the Engineering Societies' Building, Dr. Michael I. Pupin delivered an address in which a number of questions in radiotelephony were touched upon. Not only were the various problems involved in the recent developments in long-distance telephony analysed with simplicity and clarity, but Dr. Pupin declared that the great problem of "static" had at last been solved. He said that the discovery of the means of eliminating atmospheric trouble, which had cost him seven years of experimentation, not to mention the work of others, will make possible the transmission of messages by wireless telephony to every part of the world. This sounds rather too good to be true, and until the invention has been subjected to exhaustive tests we are inclined to be rather sceptical.

Dr. Pupin first took up in their historical order the various problems of wireless transmission. A broad description of the constructive elements of the wireless transmission system was given, to show that, as far as these constructive elements are concerned, there is no essential difference between the wirelesss transmission system and the ordinary electrical transmission system. But the difference, slight as it is, in the constructive elements, necessitates the introduction in the wireless system of a radically different mode of operation, namely, the employment of electrical forces of very high frequency.

The earliest method of producing these high-frequency electrical forces was briefly described, and Dr. Pupin expressed it as his personal opinion that Joseph Henry, in 1842, first discovered electrical oscillations which Marconi first employed in wireless transmission. After Professor William Thompson formulated, in 1855, the law of motion of electricity along conductors, the time was ripe for the invention of wireless telegraphy. However, it was not invented until 1895, when Marconi, stimulated by the beauty of the Hertzian experiments, and while repeating them in Righi's laboratory in Bologna, discovered that an oscillator connected to the ground and a resonator connected to the ground gave electrical transmission by electrical waves of high frequency enormously increased range. A distinct period in wireless telegraphy was inaugurated when Marconi discovered the new art. The problems which were solved during this inventive period were few, but every one of them was epoch-making. The first problem was the substitution of the high-frequency generator for the oscillator, with its noisy and unreliable spark gaps. This was accomplished by the patient and persistent work of E. F. W. Alexanderson and others.

The second great step was the introduction of amplifiers into wireless work. Dr. Pupin referred to his first announcement of the electric amplifier in 1911, made before the National Academy of Science. It was an induction generator of special construction. Since that time the vacuum tube amplifier has been developed. He referred to the work of Fleming in this connection, and pointed out that much had been accomplished in perfecting the vacuum tube with a hot cathode. Amplifiers that work with reliability and are capable of amplifying feeble electrical impulses even hundreds of thousands of times have been brought into use.

The speaker went on to point out that these tubes not only amplify, but actually

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reproduce very feeble electrical impulses with an accuracy which defies the finest microscope ever constructed.

Dr. Pupin called attention to the fact that articulate speech transmitted from Arlington to Honolulu (4,900 miles) was reproduced at Honolulu by a vacuum tube amplifier with such accuracy that the listener at Honolulu recognised the speaker at Arlington, although the energy of the feeble electrical waves conveying this speech was probably amplified 100,000 times at Honolulu.

"The third great problem solved lately by the inventive genius of man," he continued, "is that of regulating the power output of the generator at the transmitting station. To illustrate: the generator at Arlington which supplied the electrical energy for the transmission of speech to Honolulu delivered something like 100 horse-power, yet its output was regulated by the human voice. It looks as if we were on the threshold of regulating the electrical output of our high-frequency generators by what may be called mere will power. In considering all these things it would seem that there is nothing to prevent us from transmissing telegraphic and telephonic signals from any point of the earth to any other point.

"And yet there is a most serious obstacle indeed. I refer to the well-known interfering action of the static. What is the static? It is the everlasting presence of electrical waves in the terrestrial atmosphere due to electrical discharges in it. The electrical charges in the atmosphere are produced by the action of sunlight and other causes. The electrical waves produced by the electrical discharges in the atmosphere are so much more powerful than the waves coming from the distant wireless transmitting station that they drown out the messages. When means have been found to protect the receiving station effectively from the disturbing influence of the static, there will be no obstacle in the way of employing wireless telegraphy and wireless telephony as the simplest means of universal communication."

* * * * * *

MULTI-PHASE RADIO TRANSMITTERS.

Mr. William C. Woodland recently presented to the Institute of Radio Engineers a paper on the Use of Multi-phase Radio Transmitters, which is of considerable interest to all concerned with wireless engineering. The production of radio frequency current from currents of commercial frequency, says the author, is a matter of great interest and usefulness. The fact that a pure sine wave is not necessary or even desirable for radio purposes makes possible a great many ways of dividing up audio frequency current so as to duplicate the results obtained by radio frequency generators.

For example, it is possible to divide up audio frequency 3-phase currents into any number of intermediate phases, all of which have equal wave peaks occurring successively. By placing a separate radio transmitter in each phase, it would seem possible to operate at almost any desired frequency.

Several advantages of multi-phase current over single-phase current may be pointed out.

1. In an 8-phase, 60-cycle equipment the tone of the spark would be equivalent to that given by a 480-cycle generator. The condensers, however, would operate on 60-cycle current, which would allow the use of much larger capacity and a lower voltage for the same total amount of energy. The larger condensers discharging at a comparatively low voltage would give short thick sparks of low resistance, resulting in

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improved efficiency. The lower voltage would increase the life of both the condensers and the transformers.

2. The reliability of the equipment would be increased; because if a transformer or condenser should break down, the message might be finished on the other phases with no more trouble than a slight weakening of power.

3. There would be some advantage in having to break only 58 per cent. of the corresponding single-phase current at the key.

4. Spare transformers and condensers could be carried at less expense than with single-phase equipment.

5. It is possible to operate multi-phase equipments with very high-power factors and leading current, so that the generator voltage does not fall on depressing the key.

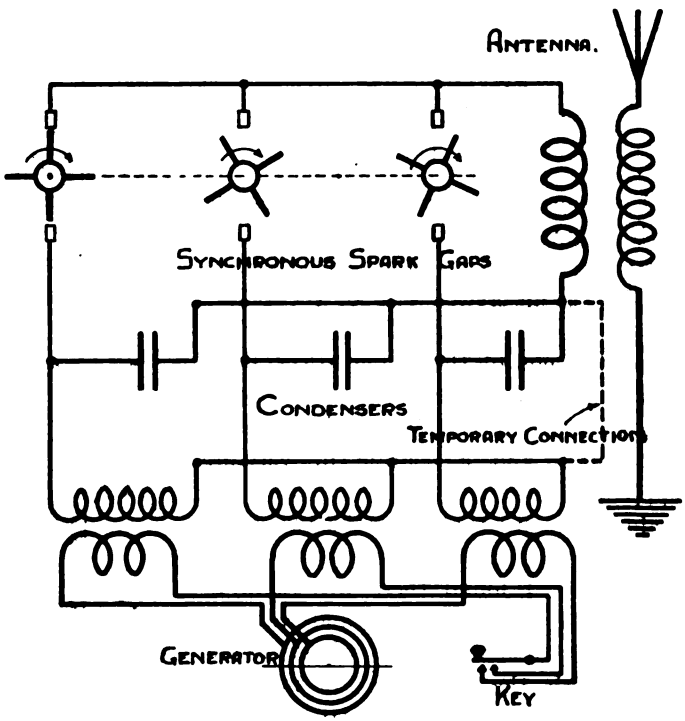
6. When operating directly on 60-cycle, 3-phase current, the efficiency is certainly very much improved.

Mr. Woodland's attention was first called to the use of multi-phase current for radio transmission in the early part of 1912, when it occurred to him that by dividing up a 3-phase, 60-cycle current, the results of the higher frequency generators might be duplicated. He did not at that time have in mind anything further than placing a separate radio transmitter of the fixed gap type in each phase, depending on it to discharge at the peak of the wave independently of the other sets.

This plan did not meet with success on account of the fact that the maximum point of the wave is not sufficiently definite to secure the phases against interference with each other. He found also that other investigators had carried the work up to this point, but that all systems had been rendered more or less inoperative because of the interference mentioned above.

All of these difficulties were overcome by the use of a rotary spark gap in each phase which had for its purpose the definite localising of the point of discharge.

The remainder of the article consists of a detailed description of the apparatus employed by Mr. Woodland, who mentions that already eight (8)-phase, five (5)-phase, four (4)-phase and three (3)-phase equipments of this description have been built with entire success.



A THREE-PHASE TRANSMITTER.

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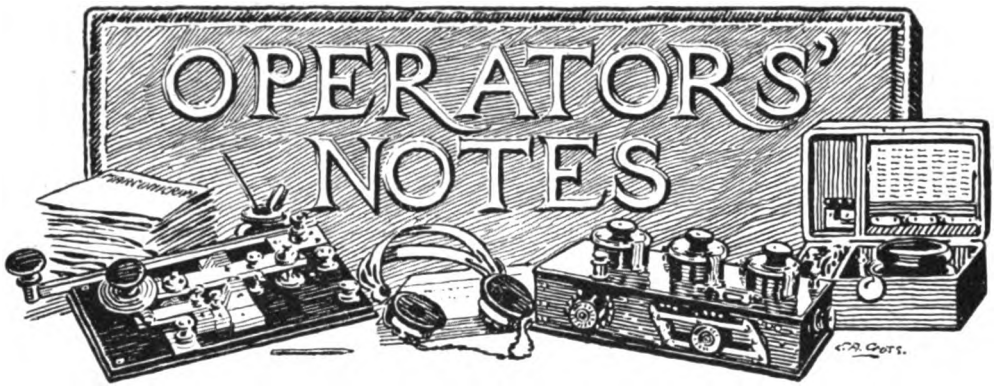

Repairing a Broken Magnetic Detector Spring

By H. W. POPE

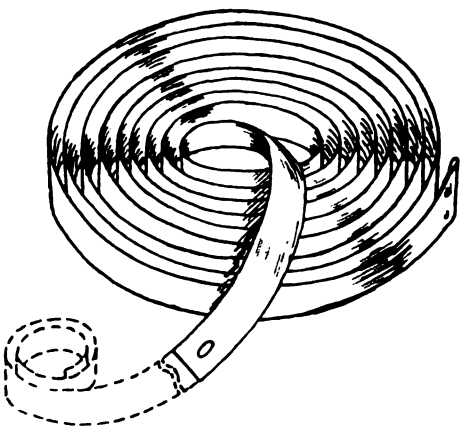

FIG. 1

Whilst I was winding a magnetic detector the other day I had the misfortune to break the spring. Casting about for a way to repair it, I hit upon the following, which was quite satisfactory.

I first fitted a handle from one of the rubber stamps to the band-wheel of the detector with a brass wood-screw, so that I could keep an intermittent watch during the repairing operations.

I next took out the spring-barrel and got the spring out with a pair of pliers, wrapping the whole job in a towel in case the spring should fly. Starting up the blow-lamp, I took the temper out of the broken end of the spring for a distance of about three inches, and drilled a fresh hole with a $\frac{3}{32}$in. drill, and opened the hole out to an oval shape with a rat-tail file.

I then unscrewed two of the pillars (A) of the spring-barrel (B), and attached the drilled end of the spring to the hook on the hub, the looped end of the spring was then passed over one of the remaining pillars, and a coating of vaseline applied. Then by taking out the two main pillars (C) that hold the two main plates together at the spring end of the mechanism, I found there was room to replace the unwound spring and barrel.

Next rebuilding the whole clockwork, with the exception of the two barrel-pillars (B) and the two pillars of the main frame (C), I wound the spring

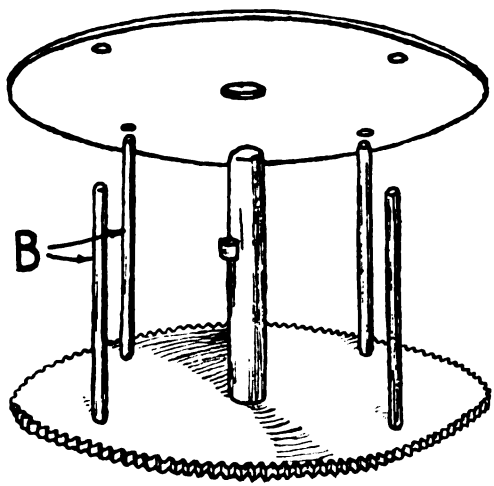

FIG. 2

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up with the ordinary winding handle and ratchet until I could see that the spring stood well inside the ring of the safety pillar holes. I then set the catch on the underside of the spring-barrel so that the spring could not unwind, and reassembled the whole mechanism; lastly, the catch was adjusted, the strain being taken off it by means of the winding handle. A thorough oiling was given, and the clockwork returned to its case. I found on trial that the detector would run for nearly the same time as it did previously, in spite of the spring being 15 inches shorter. Before the accident the detector would run for about two hours and five minutes, whereas it now runs for about one hour and forty-five minutes.

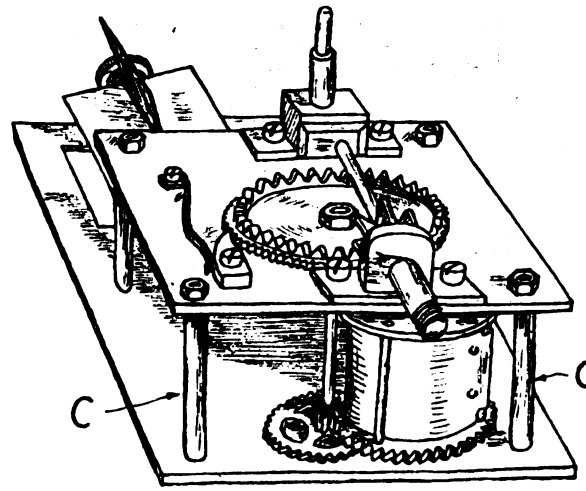

FIG. 3

President Wilson Favourable to Amateur Wireless Organisation

President Wilson has sent a letter to Mr. J. Andrew White, acting president of the National Amateur Wireless Association, New York, commenting favourably on the organisation of the amateur radio operators of the country, which, he says, would undoubtedly be a valuable asset to the nation.

Share Market Report

London, April 12th, 1916.

The market for wireless shares has been more active since the issue of the company's circular. Latest prices: Marconi Ordinary, £2 2s. 6d.; Marconi Preference, £1 17s. 6d.; Marconi International Marine, £1 5s. 6d.; American Marconi, 15s. 6d.; Canadian Marconi, 7s. 9d.; Spanish and General Wireless Trust, 5s.

At Bradford recently, Willie Slater, 21, described as a Marconi operator, was charged with having worn, without authority, a naval uniform cap. In view of the medical testimony offered, an order was made for prisoner's detention in Menston Asylum.

We are officially informed by the Marconi Company that this man was not, and never has been, in their employ.

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Dr. Fleming's Elementary Manual of Wireless Telegraphy*

Reviewed by Philip R. Coursey, B.Sc.

THE fact that this book has now reached the third edition is evidence that it is appreciated by its readers, and fills a want in the literature of the subject. It is written mainly for the use of students who wish to obtain an introduction to the technical side of the subject of wireless telegraphy. It is assumed that the reader of the book is familiar with the elementary portions of electrical engineering, such as the generation and control of electric currents, both direct and alternating, and their chief properties; and also to a certain extent with electrical measurements. The book serves as an excellent introduction to larger and more advanced treatises and text books dealing more fully with the apparatus and with the mathematical theory of the subject, such for example, as the *Principles of Electric Wave Telegraphy and Telephony*, by the same author.

The scope of the work can perhaps best be conveyed by a more detailed consideration of its contents.

The first chapter opens with some elementary facts about electric currents, the distinction between direct and alternating currents, and between undamped and damped oscillations; as well as the meaning and importance of the logarithmic decrement of the oscillations. It then quickly passes on to the "skin effect" of high frequency currents, and formulæ for the calculation of the high frequency resistance of wires and spirals.

Inductance and capacity are then explained and formulæ given for their calculation in certain standard cases, The next portion of this chapter contains a mathematical determination of the natural time period of an oscillatory circuit containing inductance, capacity, and resistance. As this involves the use of differential equations it may not perhaps appeal to many readers who are not conversant with the calculus, although the explanations given are, on the whole, very clear and easily followed. The treatment is simplified by neglecting the resistance of the circuit as this is generally very small, but unfortunately no mention is made of the effect this resistance has in the final formulæ for the frequency, as, for example, in circuits including an oscillating arc (which are described later in the book), the arc resistance in most cases causes considerable modification of what would otherwise be the natural frequency of the circuit. A brief consideration of resonance and resonance curves closes the chapter.

Chapter II. passes on to the practical production of damped electric oscillations by the discharge of a condenser, and treats in detail of the construction of induction coils, and of hammer and mercury break, and Wehnelt electrolytic interruptors for use with them. Alternators and transformers are then considered before the author passes on to spark gaps and spark voltages, with a brief account of quenched spark dischargers, and the construction of condensers and jiggers for the oscillation circuits. The description of rotary spark dischargers is, however, reserved to a later chapter on radiotele

* *An Elementary Manual of Radiotelegraphy and Radiotelephony*, by J. A. Fleming, D.Sc., F.R.S. Third Edition. Longmans, Green & Co., London. 7s. 6d.

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graphic stations, and only an exceedingly brief mention of them is made here, while in addition the somewhat erroneous impression seems to be conveyed that if tuning of the low frequency spark circuit is adopted only very low spark frequencies, such as one spark every four or five periods of the alternator, can be obtained.

In the next chapter a very good summary running into some 38 pages is given of the various methods that have been put forward for the production of undamped oscillations, by high-frequency alternators of various forms (including the Goldschmidt alternator); Poulsen and other oscillating arcs; and various methods with quenched spark dischargers yielding a continuous succession of feebly damped waves of very high group frequency. The Marconi multi-disc discharger for continuous waves is also included (Fig. 24 describing its mode of operation has, however, been inverted by the printers), although, as mentioned above, the simple synchronous disc discharger has not up to this point been described in detail. The special application of these oscillation generators to the problems of radiotelephony is set out in the last chapter of the book.

Chapter IV. is of a much more advanced nature than any of the others in the book, and treats of the theory of the propagation of electromagnetic waves through the æther. It is of necessity largely mathematical, although the treatment and the text, as is usual in Dr. Fleming's works, are clear and easily followed, while his frequent comparisons with commonplace matters or well known phenomena, both here and in other portions of the book, add considerably to its value. The mathematical sections can be omitted by the reader, if so desired, without seriously hindering the continuity of the book.

Chapter V. devoted to radiating and receiving circuits, discusses the various forms of antennæ and closed circuit radiators. A trifle too much distinction appears to be drawn between aerials which are earthed by an actual conductive connection, and those fitted with balancing capacities, as the latter, if laid out on the ground and of sufficient area, furnish a very satisfactory earth connection for signalling purposes. No mention is made of the use of stranded copper wire with each strand enamel insulated, in the section on the construction of aerials, although the material is frequently employed, especially for small aerials. The inverted cone aerial of Fig, 11 is, moreover, scarcely typical of those used in most portable stations, the inverted L or simple umbrella aerials being much easier to erect. The chapter closes with an account of various directive aerials, including the Bellini-Tosi, and other arrangements.

A good summary of various forms of oscillation detectors is given in Chapter VI. Rather more space is devoted to the more historical forms than to the ones now used in practical working. This, however, is necessary if the student is to obtain a clear grasp of the fundamentals of oscillation detectors, and of the developments that have taken place in modern forms. The tone wheel, tikker, heterodyne, and other detectors are not mentioned in this section, although they are described later under Radiotelegraphic Stations. A description of the very sensitive three electrode valves, or audions as they are generally called, might with advantage have been included as well. As the book is written for students who may perhaps be carrying out experiments for themselves, a caution might have been included in connection with the use of the Einthoven galvanometer with an oscillation valve, as the "electron-current" passing to the plate circuit of the latter (even without boosting voltage) would frequently be sufficient to destroy the fibre of the galvanometer apart altogether from any rectified signal current.

In the next chapter, on Radiotelegraphic Stations, some good illustrations and

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descriptions are given of various apparatus and complete stations, and a brief consideration of the effect of atmospheric conditions on the range of signalling. A feature of special interest to the amateur constructing his own apparatus, is the mention in many places throughout the book of convenient sizes of parts and their constructional details.

Chapter VIII., on Radiotelegraphic Measurements, describes such practical measurements as those of H.F. currents and voltages; capacity and inductance measurements, and the use of the cymometer or wave meter for the measurement of oscillation frequency and wave-length, and for the delineation of resonance curves and their use in the determination of decrements. The information in this chapter should be of especial use to the laboratory student.

In the last chapter the author gives a summary of the problems of radiotelephony using the various forms of undamped oscillation generator described in Chapter III., and of the results achieved up to 1915. The mention of liquid microphones with which most of the long distance work has been achieved is very brief. A short description of the "valve" oscillation generators as used by the Marconi Co. is also given.

The book contains some 190 illustrations and is closed with a useful index, in which, however, further references to some of the more recently added portions of the book might well be included. As a whole, it is well printed on good paper, and in spite of a few small misprints which have crept into the text, should be eminently suited to retain the position of good repute which its earlier editions have already attained.

Answers to "Wireless World" Problems

WE have pleasure in printing below the answers to the two problems presented to our readers in the April issue. The first problem, it will be remembered, was as follows:—

A condenser (capacity 12 milli-microfarads) is made up of twelve smaller condensers of four different sizes (in parallel), viz.,—4, 2, 0·5, and 0·25 milli-microfarads, respectively. How many of each size are there?

This is a problem for the mathematicians and others who have benefited from the Instructional Articles in THE WIRELESS WORLD. The solution is as follows:—

It is clear that there can only be *one* of the largest size, for two of 4 mmfds. and one of 2 mmfds. gives 10 mmfds. for only three condensers, leaving 2 mmfds. for nine condensers. Hence, let $x\ y\ z$ be numbers of other sizes respectively,

Then $1+x+y+z=12$,—*i.e.*, $x+y=11-z$ . . . . . (1)

and $4+2x+\frac{y}{2}+\frac{z}{4}=12$,—*i.e.*, $4x+y=16-\frac{z}{2}$ . . . . . (2)

Solving (1) and (2) gives $3x=5+\frac{z}{2}$ . . . . . (3)

$$3y=28-\frac{7z}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Now (3) and (4) are divisible by 3, and therefore $z=2$, whence $x=2$, $y=7$.

$\therefore$ 1, 2, 7, 2, are respectively the numbers of condensers of each size.

The answer to the Electrician Christie's amusing problem is that 2 gallons of petrol will find 9,261 Germans in a week. We hope so.

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WIRELESS NEUTRALITY.

THE lot of a neutral must sometimes be a very hard one, and it is made especially hard when one of the belligerents happens to be Germany, whose impudent pretensions can be characterised by no less an adjective than " colossal."

Shame is totally absent from them, and both the Central Powers have had to withdraw diplomatic representatives from the United States, whose patience, though long-suffering, became finally exhausted. Baffled by American vigilance with regard to their wireless plots at Sayville, they nevertheless have recently had the effrontery to protest against the suppression by the American wireless censors of the German Admiralty's announcement regarding the sinking of the British mine-sweeper *Arabis*, and in this instance were even able to extract from the U.S. Secretary of the Navy a promise that there should be no censoring of wireless information coming officially from a foreign Government when such information had already been printed in the territory of the enemy country.

So much for the treatment which Uncle Sam receives from the Hun. As far as Great Britain and her Allies are concerned, American statesmen were always ready to acknowledge that diplomatic conduct has invariably been absolutely " correct." But from this side also the " inevitableness of things " has constantly brought troublesome questions on the *tapis*. Sir Cecil Spring Rice, the British Ambassador, has on more than one occasion found himself obliged to make communications to Mr. Lansing about German secret wireless stations, and British subjects constantly ask that protests shall be made against what appears to them as " complacency " displayed by the American Government towards the wireless lucubrations of Germany.

These come, as often as not, from Britishers resident in other parts of the empire than the " old country." Here we are all too used to having the British lion's tail twisted by our cousins across the water, and look upon such a procedure as " Pretty Fanny's Way." But our Colonial fellow-subjects are less complacent, and the Sydney *Sun* not long ago published a memorial from Australian travellers relating to their voyage on one of the American steamers engaged in the conveyance of Australian mails and passengers across the Pacific. Our Antipodean contemporary comments :—

> " It is about time the Federal Government did something to protect Aus-
> " tralians travelling by American steamers from German faked wireless news
> " services when crossing the Pacific."

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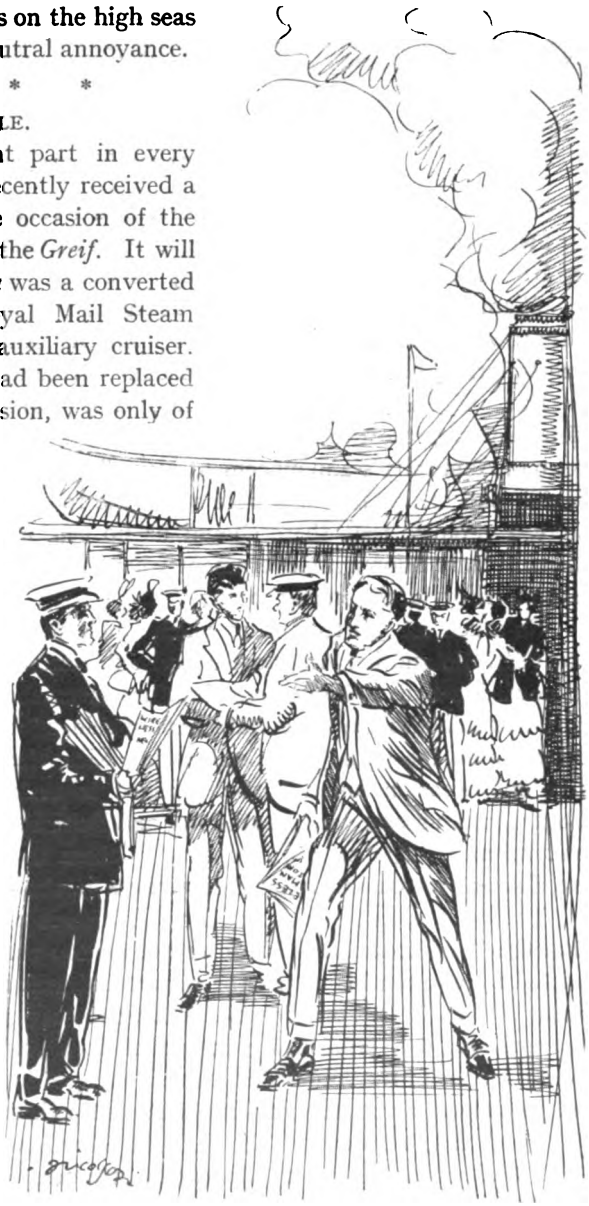
The Australian journal certainly made out a good case and produced a formidable list of imaginary British reverses and German successes, printed in the ship's wireless newspaper.

A most benevolent neutrality was displayed towards German war news and a most grudging neutrality marked the news about the Allies. Yet ***half the cargo and more than half the passengers carried by these steamers are supplied by Australia.*** The *Sun*, therefore, suggests that the Commonwealth Government might, irrespective of the British Imperial authorities, approach the United States authorities independently, and endeavour to induce the latter to take steps for the protection of Australasians on the high seas against such intolerable and unneutral annoyance.

* * * * * *

A WIRELESS BATTLE.

Wireless plays an important part in every operation at sea, and this fact recently received a most striking illustration on the occasion of the battle between the *Alcantara* and the *Greif*. It will be remembered that the *Alcantara* was a converted liner taken over from the Royal Mail Steam Packet Co. and fitted out as an auxiliary cruiser. Her wireless apparatus, unless it had been replaced by fresh fittings since her conversion, was only of that power which was settled by the Berne Convention as not to be exceeded by merchant vessels. German ships notoriously evade these regulations, and it is quite plain that the apparatus employed on the *Greif* was of a far more powerful nature than that of the English vessel. As soon as the concealed enemy disclosed her true character and started to jam the signals of the *Alcantara*, she cut the latter's wave-length with remarkable readiness, so that a stubborn action was fought between the wireless rooms as well as between the guns. With regard to the latter, the weight of metal appears to have been on the side of the Germans, but the superiority in gunnery combined with more skilful



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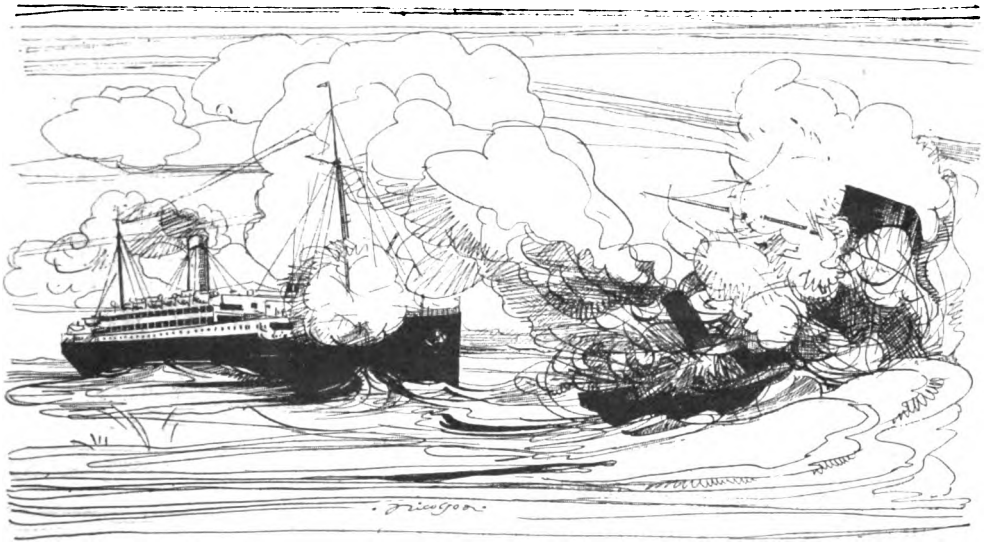

seamanship, enabled the British to outclass and overcome the enemy. Still, the wireless superiority of the latter prevented the British vessel from sending out calls for assistance, or any advice of the fierce struggle in which she was engaged, and it was not until her guns had wrecked the *Greif's* wireless cabin, and put her radiotelegraphic apparatus out of commission, that the word flashed forth to all the patrolling ships in the neighbourhood that the *Alcantara* had caught a raider and was engaged on an unequal struggle. We do not know whether it was the *Alcantara's* wireless message, released from jamming, or the sound of gunfire which brought the other vessels to the spot. When they arrived, the issue was already decided, and the *Alcantara* had won a remarkable victory. Accounts differ as to whether the torpedo which was responsible for the British cruiser sharing the fate of her adversary was fired from the *Greif* in her death-throe or from an attendant submarine. But, from whichever cause it may have arisen, every indication appears to point to the fact that the British cruiser fell a victim to an honourable attempt to save as many as possible of the *Greif's* crew from a watery grave. The whole incident reflects great credit upon our British sailors, and illustrates the fact that wireless strategy and tactics have become as important as " coal strategy." Where our fathers fought with one weapon we have to fight with ten, and the brain of the commander must be an alert and receptive thing.

* * * * * *

The Crowded Æther.

It must be many years since the waters of the Mediterranean were ploughed by so many war vessels as is the case to-day. Indeed, if the tale be reckoned up completely, so as to include fighting ships of all sizes, patrol boats, transports, *et hoc genus omne*, I suppose that these present days may be taken to be producing records. Practically every vessel carries wireless, and, although some of them are not permitted to despatch messages unless in exceptional circumstances, there is a vast conglomeration of message-bearing æther waves of varying lengths and intensity, criss-crossing each other in an

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amazing way. Over and above the inter-ship messages, there is the ordinary traffic of Marconigrams, besides all the Press war messages from the Entente stations on their way to the East, Admiralty code messages and signals from a large number of land stations, including the enemy installations in Turkey and Bulgaria, prominent amongst which is Ok Meidan station. Less distinct, but still audible and recordable, come the æther waves from the German Norddeich station near Berlin. Are we not justified in characterising the æther as decidedly overcrowded ?

* * * * * *

WIRELESS ANIMALS AND ARCANA.

In our issue No. 28 of July, 1915, we inserted a note about a ***wireless dog***, and recently our attention has been directed by one of the Grand Fleet chaplains to a ***wireless cat***. The reverend gentleman insists upon the sacrosanct nature of the wireless room, and warns all and sundry that whatever else on his battleship he may be permitted to show them there is one spot treated with reverence, a very Holy of Holies, unapproachable save by the high priests of radiotelegraphy ! That spot is the wireless room. The reverend gentleman himself appears to have penetrated into it on one occasion, at all events, and witnessed the ***arcana*** contained therein. He is anxious not to " divulge " any of the mysteries," but ventures to say that " it is very different in general economy " from the wireless room of a dozen years " ago." There is, says he, but one outsider who possesses a " free run " there. This is the ***wireless cat***, a creature " endowed by nature with an " aptitude for the pursuit of science." The chaplain's picture of the absolute imperturbability of this favoured animal to the weird sights and sounds which day and night pervade this room are both instructive and amusing. As the pet and property of the operating staff, on the analogy of most of the books pertaining to this specialised branch of signalling, it is generally described as " the Wireless Cat with Addendum " One." Whenever it wants to signal " annoy- " ance " it radiates the message in wireless waves by means of its ***addendum***. The reverend chronicler closes his description with the remark that this interesting specimen of the feline tribe belongs to the softer sex and is—at present—***télégraphie sans " fille."***

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En Hâte, mais sans Précipitation.

Amongst their other delightful characteristics our French Allies have been distinguished throughout their long and glorious history for their faculty of neat expression. An amusing example is furnished in the columns of one of our contemporaries. Dealing with the services rendered by Wireless, the French journalist relates how, by this means, the lives of the citizens of Nancy are preserved from destruction by the shells of the Boches.

"The great siege guns of the enemy are kept under observation, and the "moment one is fired our air scout gives notice by wireless telegraphy, and the town "siren hoots. Now radiotelegraphy "moves faster than shells and, during "the short interval between the start "of the shell and its arrival, sufficient "time elapses for the siren to sound "the alarm fifty seconds in ad-"vance." The City Fathers have warned those under their care that this notice should suffice for persons domiciled within the danger zone to leave the upper regions of the house and take refuge in the cellars "en "hâte, mais sans précipitation"—*with hurry but without flurry.*

Our French journalist expresses a pious hope that the Mayor will give some rehearsals in the City Hall so that the citizens of Nancy may see with their own eyes "how their "worthy Mayor makes his retirement "from garret to cellar with hurry "but without flurry." As French Mayors are traditionally as fond of the "good things of life" as their English prototypes, M. le Maire is probably already "bombé" in another sense, and such a "rehearsal" would be likely to prove interesting.

* * * * * *

Rescued from the Germano-Turks.

The attention of the world at large has been recently struck by the successful activity of our Russian Allies in Asia Minor and Mesopotamia. Their magnificent exploit in the capture of Erzerum and their further successes at Bitlis and Trebizond, which we all hope to see speedily consummated by the total expulsion of the Ottoman troops from Armenia and Mesopotamia, have recalled to our minds the sufferings of the Armenians at the hands of the Turks through a long continued series of years. These sufferings culminated in the awful slaughter perpetrated by these same Ottoman perse-

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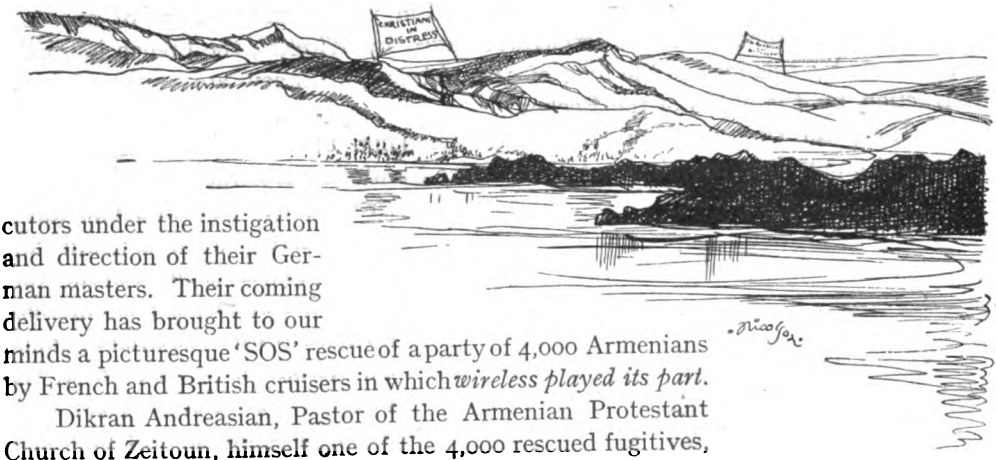
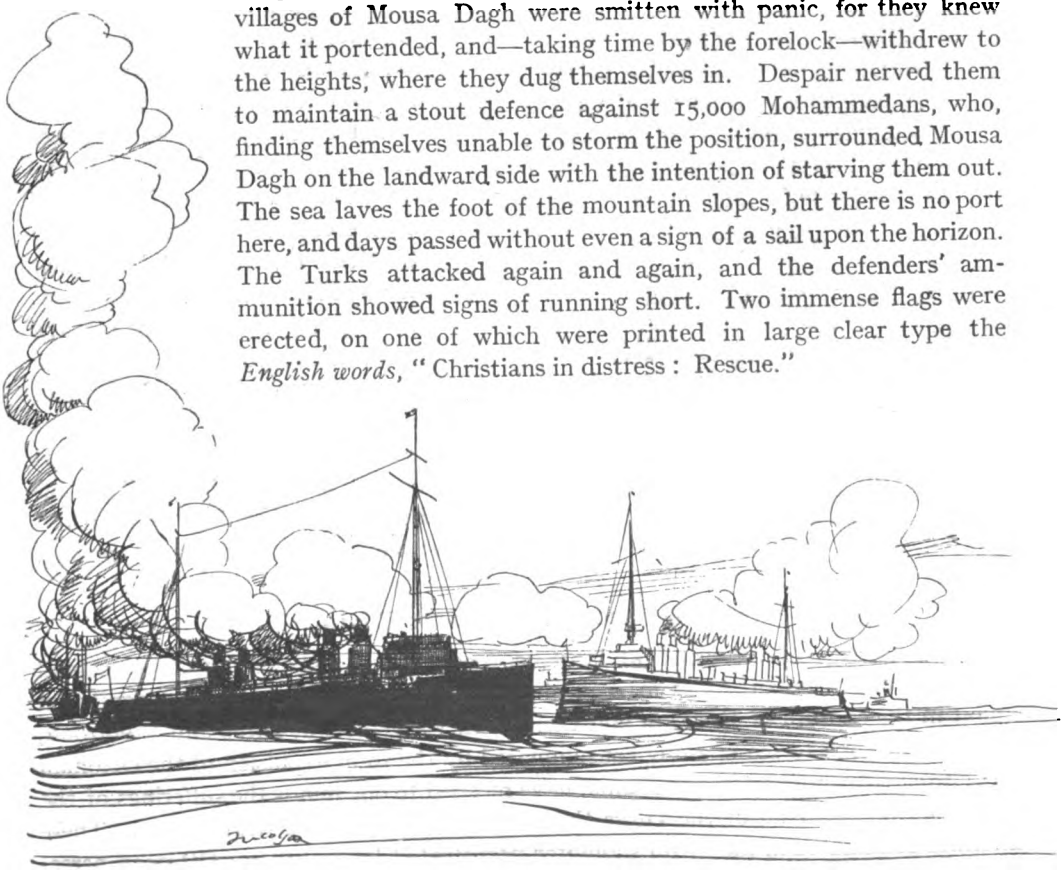


cutors under the instigation and direction of their German masters. Their coming delivery has brought to our minds a picturesque 'SOS' rescue of a party of 4,000 Armenians by French and British cruisers in which *wireless played its part.*

Dikran Andreasian, Pastor of the Armenian Protestant Church of Zeitoun, himself one of the 4,000 rescued fugitives, tells the tale. **Notified from Antioch by the Turkish Government to prepare for banishment, the Armenian inhabitants of six** villages of Mousa Dagh were smitten with panic, for they knew what it portended, and—taking time by the forelock—withdrew to the heights, where they dug themselves in. Despair nerved them to maintain a stout defence against 15,000 Mohammedans, who, finding themselves unable to storm the position, surrounded Mousa Dagh on the landward side with the intention of starving them out. The sea laves the foot of the mountain slopes, but there is no port here, and days passed without even a sign of a sail upon the horizon. The Turks attacked again and again, and the defenders' ammunition showed signs of running short. Two immense flags were erected, on one of which were printed in large clear type the *English words,* "Christians in distress: Rescue."



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One Sunday morning, the 53rd day of the siege, the French four-funnelled *Guichen* came in sight and communication was established with her. The commander, unable to deal with so great a number himself, sent a *wireless message* to the Admiral of the Fleet for instructions, and, before very long, the flagship *Ste. Jeanne d'Arc* appeared, followed by other Entente war vessels. Thus, through the instrumentality of radio-telegraphy, there were rescued from an awful fate, 427 babies under 4 years of age, 508 girls, and 2,495 men and women above 14 years of age.

* * * * * *

Turkish Fiction and British Fact.

The Constantinople bulletins issued by the German Wireless have for some time past been making claims to have won successes against the various British forces in Mesopotamia. Many of those claims are altogether without foundation, a fact which has several times been officially exposed by the British Government. Others rest on the retirement of reconnoitring forces, after the achievement of their object, to the main body to which they belong. These are represented as retreats after defeat. Amongst letters home from members of the fighting parties in this district some interesting examples were recently published in the *Times* from an officer belonging to the British Force at Kut-el-Amara, who has been in action. The account given of the composition of such a reconnoitring party, thrown out from every main force in its advance with the object of collecting information and gathering supplies, will illustrate the part played by wireless and expose the attempts of the enemy to create a deceptive impression of success out of the safe return of such patrols. Our correspondent's letter states: "I "was in command of the column—a "small one—consisting of half a battery "of Royal Horse Artillery, one squadron "cavalry, one double company and "*pack wireless*. We had a small scrap 25 miles out, but luckily (or unluckily) the "enemy was not a raiding party, but consisted merely of a few truculent Arabs, whom "a couple of shells and a little long-range fire soon dispersed to the four winds, and "we resumed our march unmolested, to the great relief of the Division *with whom I* "*had been in communication by wireless.*" On this occasion our British officer brought his reconnoitring column safely back and duly made his report to headquarters.

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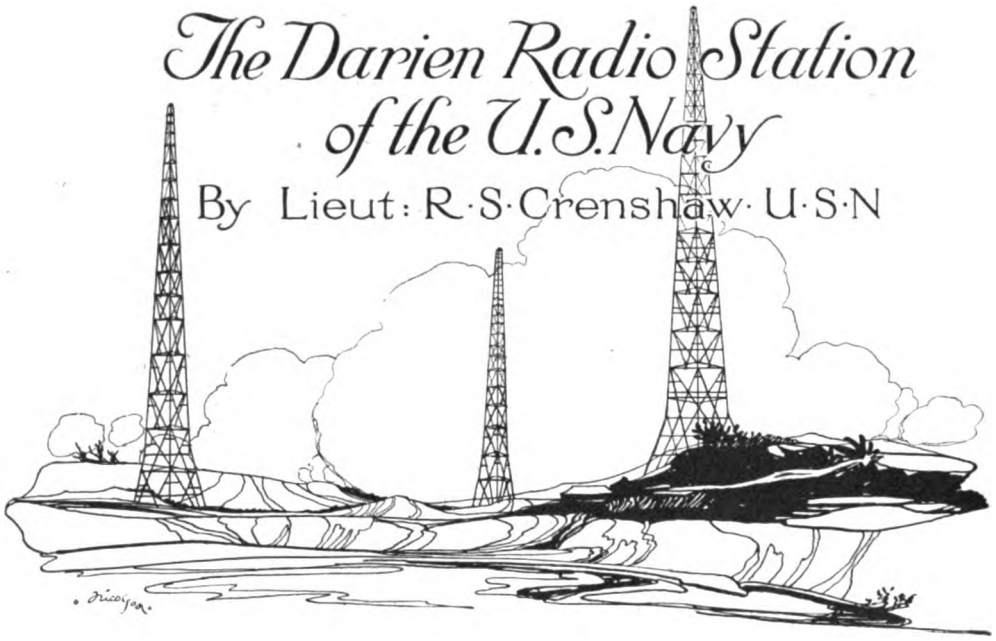
The Darien Radio Station of the U.S. Navy

By Lieut: R.S. Crenshaw. U.S.N



(*Abbreviated from the Proceedings of the Institute of Radio Engineers, N.Y.*)

LINE DRAWINGS BY J. W. NICOLSON.

IN its system of radio communication for the canal zone the Navy has maintained the high standard set by the canal in general in having thoroughly modern equipment. The layout comprises one coastal station at each end of the canal for ship to shore work.

The Darien radio station is located just twenty-five miles south of Colon on the Panama Railroad. The railroad runs from the east boundary of the reservation, which contains eighty-seven and one-half acres. The south-west boundary is the canal itself, from which runs a channel 20 ft. deep and 75 ft. wide into the centre of the station plot.

Work was started on construction in December, 1913, by the Quartermaster's Department of the Panama Canal.

The dwellings on the site are the house for the Radio Officer, cottage for the chief electrician in charge, and barracks for the operators, equipped to house seventeen men. Servants' quarters are also provided in the barracks building. Rations are commuted at a dollar a day per man, and a mess is run by the operators.

All the buildings are screened, including the porches. There is such a large breeding area for mosquitoes about the site, that the cost would prohibit sufficient sanitation work to keep the mosquitoes down entirely, and the means adopted are: (1) to keep the screening as tight as possible; (2) each morning a sanitary inspector makes the rounds and catches the mosquitoes inside the living quarters and office; (3) no containers are allowed to collect water in which there may be breeding on the station site; (4) all drains are kept clear so that no water stands in puddles; (5) around the edge of the water the bank is kept skinned to allow the small fish to eat the mosquito larvæ (this means is remarkably effective); (6) the force of five labourers allowed the station is kept at work on the grounds to keep the jungle growth cut down as well as possible.

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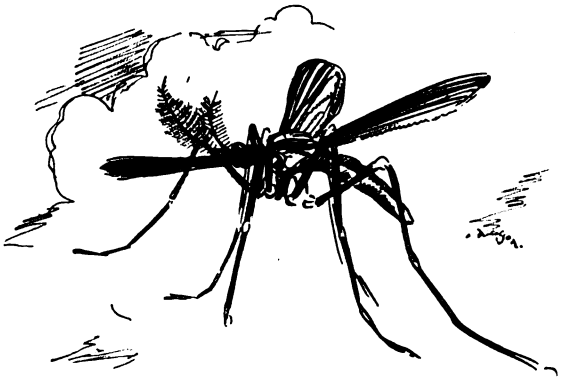
When one case of malaria appeared, the whole station was put on a quinine diet for ten days in order to prevent an epidemic.

The other buildings of the station, with the exception of the boat-house, are of concrete. The boat-house is of old form lumber left over from the concrete work, and corrugated iron roofing robbed from old, abandoned shacks on the site, one of which was a distillery.

The power-house is 60 ft. by 30 ft., and contains the motor generators for the main transmitting set.



ANOPHELINE MOSQUITO—
THE "TERROR OF PANAMA"

The main distributing and controlling switchboards are here, with the auxiliary transformers. This building also houses the machine tools, a small lathe, a drill press, milling machine, and emery grinder, and is fitted with a 5-ton overhead travelling crane. All wiring is in conduit in wire trenches.

The operating building contains the arc room (where is located the main transmitting set with its auxiliary electric controlling devices), the receiving room, and the office, beside a spare room for an auxiliary sending set if needed later. The arc room and the receiving room both have wire mesh embedded in their walls, floor, and ceiling, in order to prevent induction from the transmitting set injuring the receivers. The building is fireproof, which is necessary on account of the action of the continuous oscillations used at such high voltage. The charging current into iron in the vicinity of any live lead heats the iron quickly. Some of the reinforcing had to be taken out of one concrete base because the current jumped to it, and one wall, 19 in. (47 centimetres) away from the end of the helix, heats so that the hand cannot be kept on it after a twenty-minute run. The reinforcement in this wall is merely metal lathing, but it is directly in the field of the main helix.

THE SANITARY INSPECTOR

The contract for the towers was let to the Penn Bridge Co., which, in turn, sublet the fabrications to the Toledo Bridge and Iron Works, and the erection to Mr. J. O. Childers. In all three towers there are about 1,000 tons of structural steel. They are 600 ft. (183 metres) high each; the feet form a triangle 150 ft. (46 metres) on a side, and the tower tapers to a 10-foot (3 metres) triangle at the top. An iron ladder runs up the outside of one leg on each tower, having rest platforms about every 50 ft. (15.2 metres).

When first erected there was considerable swaying in the bottom long diagonals, but these and others above were stiffened up by cross bracing,

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and now they are perfectly rigid. When the antenna was hoisted and adjusted to the sag, which would give a pull of about 13,000 lb. (5,500 kilograms), the top of each tower was pulled over only 4 in. (10 centimetres) during hoisting, and settled back to 2 in. (5 centimetres), when hoisting stopped. All the bend was in the upper 200 ft. (60 metres).

As mentioned earlier in this article, it was the first intention to locate the towers on the tops of the hills, but on making the actual location, it was found that the thrusts (which come on to the footing at the angle of slightly over 16° from the vertical) would be nearly too parallel to the face of the hills to give solid backing for the footings. They were finally located, so that all footings except one butt into the hills. In order to do this, however, the footings were put on about the 120-foot (36 metres) level instead of the 170-ft. (52 metres). The surface of Gatun Lake is normally at the 85-ft. (26 metres) level. The block for each footing is 16 ft. (5 metres) deep and 20 ft. (6 metres) square, heavily reinforced with old railroad rail. Each block filled entirely the hole excavated for it without back filling, in order to have it bearing in undisturbed earth. The distance between towers is: One and two, 897 ft. (273 metres), two and three, 751 ft. (254 metres), one and three, 969 ft. (295 metres), the antenna covering about six acres.

The Darien towers being farther apart, and not so directly beneath the antenna, seem not to affect the capacity as at Arlington. Darien evidently has a greater effective height than Arlington.

A TYPICAL NATIVE VILLAGE

"LABOURERS KEEP THE JUNGLE GROWTH CUT DOWN"

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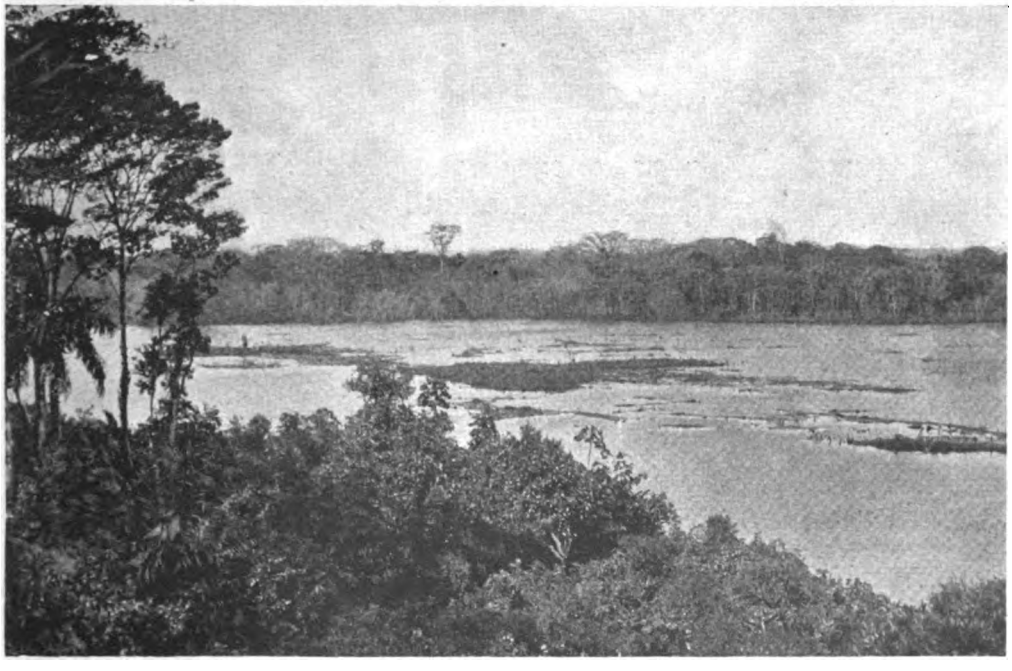
The antenna was made at New York Navy Yard and shipped to Darien, each wire on a separate reel, and tagged to mark the points where other wire crossed. The cables are all phosphor-bronze, the outside ones being ¾-in. (1.9 centimetre) diameter, the four strain cables through the mast, ⅜ in. (0.9 centimetre) diameter, and the sixty-six radiating wires of regular antenna wire. The first 150 ft. (48 metres) of the down land of twenty-six wire is a fan, and is then grouped by spacing hoops to form the rat-tail. Each corner is insulated with the Arlington type of Locke insulators with, however, two strings in parallel, as the strain was too near the mechanical breaking limit of the insulators. Lightning has already struck the antenna twice without damage, because of the safety gap feature of these insulators and the towers being grounded. An electric winch on each tower furnishes the power needed for handling the antenna. The feet of each tower are insulated.

The feet rest on ten porcelain block insulators 11 in. (27.9 centimetres) high, having each three petticoats. Insulators are also placed under the yokes, which secure to the anchor bolts for taking the upward thrusts, and others are placed between the footing and the channel irons projecting from the block to take the side thrusts. However, the arc " pulls " better with the towers grounded, so they are operated in that condition by being grounded through large knife switches to the ground system of the station.

The general ground conditions of this site are excellent, since the Gatun Lake lies on three sides of it, with an arm reaching into the centre of the station plot. An artificial ground was laid in addition to cover all the land as follows : 100,000 ft. (30,000 metres) of annealed copper wire was laid in the shape of a grid, forming rectangles about



GATUN LAKE, WHICH HAS BEEN UTILISED TO FORM AN INTEGRAL PART OF THE PANAMA CANAL.

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50 ft. (15 metres) on a side. All inter-sections were soldered; the ends of all wires, on reaching the water's edge, were run 100 ft. (30 metres) into the lake, and the main ground plate and the ground plate for each tower are tied into the large grid by busses reaching well out into it. This ground system is buried about 4 in. (10 centimetres) for projection.

The signalling is done by short circuiting or opening a compensation helix in series in the antenna circuit. The key for accomplishing this contains 13 pairs of points mounted on a yoke in parallel, so that each pair of points breaks only the voltage due to one turn of the auxiliary helix. This yoke is on the armature of a solenoid, the current controlling which is broken in a strong magnet field, and the key is thus positive and fast in action. The D.C. supply is protected from the radio-frequency current by having air core choke coils in both positive and negative lead to the machines. There are field spools in the negative lead, and carbon rod protection in the power-house guards further against high voltages getting into the D.C. generators. This set gives Arlington a signal easily readable through all but the worst electrical storms.

The arc can be controlled entirely from the operator's seat, the main generator voltage being controlled there, circuit breakers closed or tripped, the arc struck and starting resistance arc short-circuited. While running, the arc is regulated to take up the wear of the carbon by foot pedals, so that the operator may not have to interrupt his sending. All circuits are electrically interlocked, so that on starting the correct sequence must be followed.

Only Government work is handled by this station, and at present there is not enough of this to demand continuous watch so that schedules are run. The comple-

THE PLAZA AND CATHEDRAL, PANAMA. THE SQUARES OF LATIN AMERICA ARE REMARKABLE FOR THEIR BEAUTY.

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ment requires eight operators on watch, two at a time, a chief radio electrician in general charge, a hospital steward of the Navy in charge of sanitation and general health work, a yeoman (who is a clerk for the station and for the Radio Officer), and a machinist. Five labourers are employed on the grounds, which were high jungle when the station was built. The Radio Officer of the canal zone lives here, having his office in that of the station. With excellent telegraph and telephone service to all parts of the Isthmus, the station, though isolated, is in close touch with the Canal Government.

Postmaster-General's Report

The following is an extract from the Postmaster-General's Annual Report, which has just been published :—

" *Wireless Telegraphy*.—Between April 1st and July 31st, 1914, 326 new licences " had been issued under the Wireless Telegraphy Act for experiments or the reception " of time-signals, while 131 licences for experimental stations had been cancelled or " had expired. In 26 cases permission to conduct temporary experiments was given " by letter. On the outbreak of war there were in existence 2,158 licences for private " land stations as compared with 1,963 on March 31st, 1914. No licences for fresh " stations have since been issued, and all existing stations, except a few required for " Government work, have been dismantled. Private apparatus generally has been " taken into Post Office custody for the period of the war. Under the Defence of the " Realm Regulations measures have been taken to prevent the use of unauthorised " wireless apparatus.

" At the end of July, 1914, there were 942 merchant ships registered in the United " Kingdom carrying wireless apparatus under licence from the Postmaster-General, as " compared with 879 ships on March 31st, 1914. The number of radiotelegrams dealt " with at the Post Office Coast Stations between April 1st and July 31st, 1914, was " 26,145 (21,911 inwards and 4,234 outwards), as compared with 19,942 during the " corresponding period of the previous year—an increase of about 31 per cent."

Colonial Import Duty

Information relating to the rates of import duty leviable in the British Self-Governing Dominions, Colonies, Possessions, and Protectorates, is contained in the return recently published by the Board of Trade on " Colonial Import Duties, 1915." The Return is arranged with the object of bringing together the various tariff classifications and rates of duty for each principal group of articles, the information being shown for each British Possession under each group. Electric machinery and apparatus (including wireless telegraphy) forms one of the headings into which the groups are divided.

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To Our Readers

THE recent controversy as to the presence in Paris, at the Entente Economic Council, of Mr. Hughes, the Australian Prime Minister, has somewhat forcibly reminded many of us of the famous declaration of policy on the part of George Canning, which he introduced into the King's Message of December 12th, 1826: "I have called the New World into existence to redress the balance of the Old." George Canning, it will be remembered, was the most progressive of the British Foreign Ministers in the early part of the nineteenth century; and it is interesting at the present juncture to remember that he was responsible for the treaty which combined England, France and Russia for the settlement of the affairs of Greece.

This far-sighted policy has been recently carried to lengths undreamed of by our nineteenth century statesmen; it has met with a glorious response, and the way in which Australia, New Zealand, Canada, India, and indeed all the British Overseas Colonies and Dominions, have rallied to the support of their Motherland in her fight for Civilisation against "Kultur" has rendered praise not only superfluous but impertinent.

All of them have recognised that, though far away, they are closely concerned in the titanic struggle. I recently came across a long article published in a leading Australian newspaper which bears directly upon the point. The antipodean journalist placed in the forefront of his argument the "indirect but unmistakable evidence" of Germany's designs on the Commonwealth as evidenced by "the numerous wireless stations which she "established round and about us prior to the war." Besides a number of plants of small power, intended only for inter-island communication, there were four installations, containing ocean plants of high power, located in German East Africa, German New Guinea, German Carolines, and German Samoa. Communication could be established with Berlin, and these powerful stations were able to exercise a most undesirably inimical influence throughout the Indian and Pacific Oceans. Taking into account the insignificance of the German colonies, it would be the height of fatuousness to accept domestic needs as the explanation for their existence. No! they were "war plants" in the fullest sense of the words, important tentacles of the Teutonic octopus whose deliberate intention was to strangle the independence of Britain overseas.

Australians, moreover, have never forgotten the war-plot which was really responsible for the disappearance of the German fleet at Kiao-Chau, synchronising with the acute stage of the Agadir crisis four years ago. Five powerful vessels of war were suddenly "lost" in the Pacific Ocean. Thanks

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to a fortunate accident which took an Australian ship near New Guinea *en route* to Sydney, it was discovered that the German war-fleet was lurking off Rabaul with steam up, ready to head for Australia at a moment's notice immediately on receipt of a wireless message from Berlin.

The radio-telegraphic work of the Australian Government has been immensely increased since the outbreak of war. We are proud to know that the Amalgamated Wireless (Australasia) Company has rendered invaluable assistance to the naval and military authorities. They were in possession of the only organisation capable of affording this help, and the Directors placed the entire organisation unreservedly at the disposal of the Commonwealth for war purposes as soon as hostilities opened. Naturally we are not at liberty to speak in detail of the Company's manifold activities in this direction, but we have the satisfaction of knowing that it has already received official recognition.

In matters wireless, as in other spheres, the children of Britannia have rushed to her aid. On the Gallipoli Peninsula the wireless equipment of the Australian Light Horse signal troops performed useful service, and more recently still the first complete wireless signal corps organised in Australia sailed to play their part in active service. New South Wales and Victoria contribute each their quota of men, and it is a highly satisfactory evidence of the patriotic activities of the Amalgamated Wireless (Australasia), Ltd., that a large number of experienced telegraphists, in the course of receiving their wireless training at the Marconi School, 97, Clarence Street, Sydney, marched to the Town Hall and enlisted, as soon as the urgency of the call for recruits was realised. The Australian papers have celebrated the organisation and dispatch with the greatest enthusiasm, and published on behalf of the citizens of the great Commonwealth a hearty farewell greeting to " this little coterie of Australians destined to serve as strangers " in a strange land."

When we count up the assistance given by the Australians, in money, in valiant soldiers, in statesmen, in economists, and in wireless telegraphy, are we not justified in saying that, in a sense truer than any which applied in the day of George Canning, our own beloved monarch is " calling in the " New World to redress the balance of the Old " ?

The Editor

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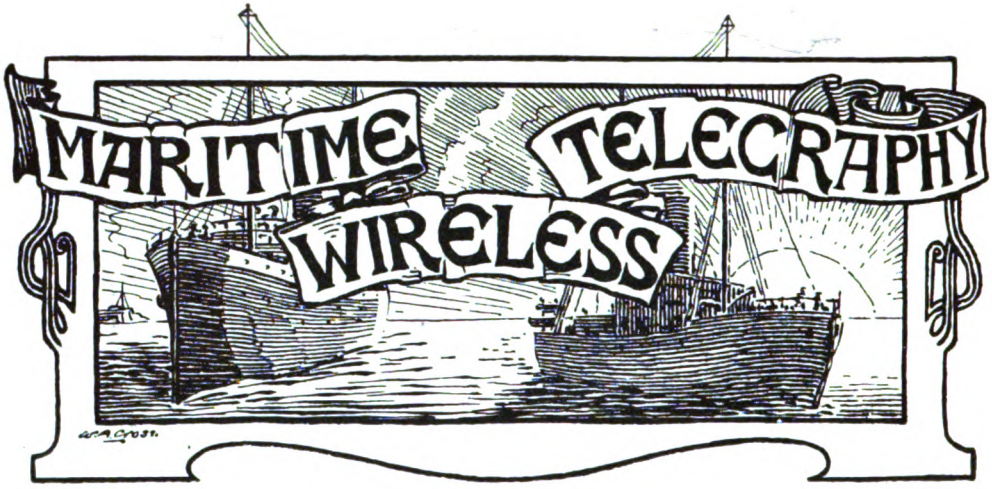


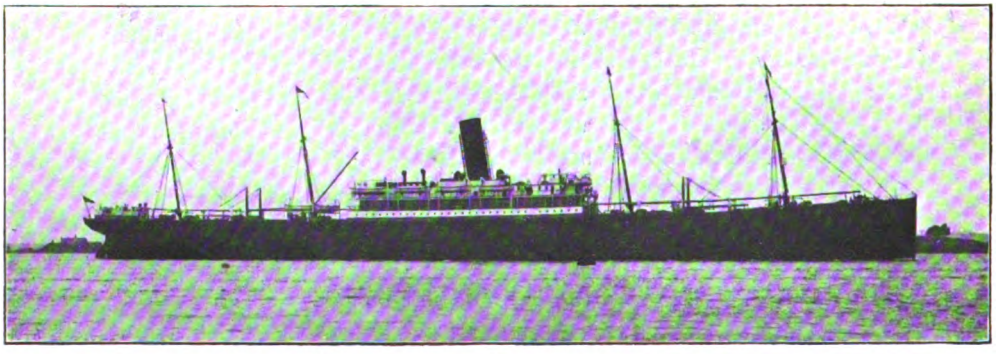
Loss of the "Englishman."

In connection with the sinking of the s.s. *Englishman* it should be placed on record that the Marconi operator was able to get into touch with another vessel before he left his ship. The *Englishman* was outward bound, and carried no passengers. The 10 victims include 7 horse attendants, 3 of whom were American citizens. Most of the survivors of the lost liner have now reached port.

* * * * * *

Atlantic Liner Sunk.

The large British steamer, *Minneapolis*, of 13,543 tons gross, has been torpedoed and sunk in the Mediterranean. She carried a large crew, all of whom were saved, with the exception of eleven, who, unfortunately, were killed. Wireless appeals for help were sent broadcast, and this was doubtless responsible for the small loss of life. We are enabled to reproduce a photograph of the lost steamer. She was one of the best known Atlantic liners, and was built for the Atlantic Transport Company by Harland and Wolff, at Belfast, in 1900. In normal times she carried a number of first class passengers.



THE S.S. "MINNEAPOLIS," WHICH WAS TORPEDOED AND SUNK IN THE MEDITERRANEAN WITH A LOSS OF ELEVEN LIVES.

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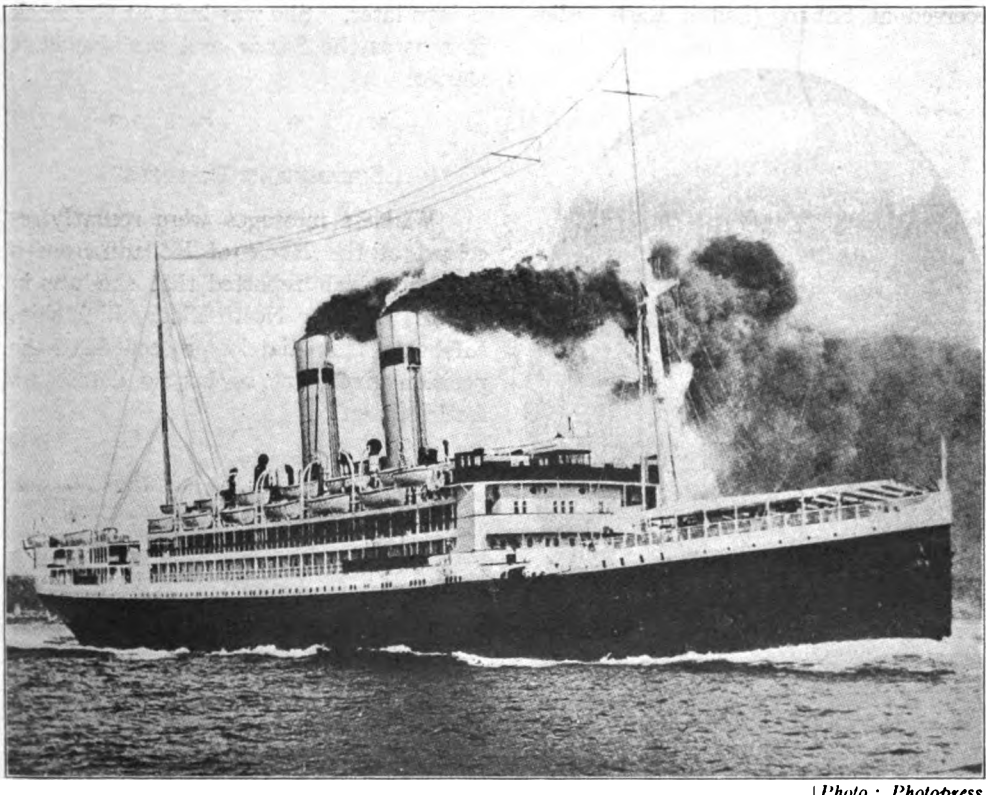
DUTCH LINER TORPEDOED.

The Royal Dutch Lloyd liner *Tubantia*, of 13,911 tons, which was on a voyage from Amsterdam to Buenos Aires, was torpedoed and sunk two miles from the North Hinder Lightship (38 miles west of Flushing). Thus was another dastardly act committed by the German pirates, with their usual brutal callousness. Her SOS calls were answered both from England and Holland, and, fortunately, all the passengers and crew were saved. A delayed wireless message received at Ymuiden from the *Tubantia, via* Scheveningen, ran: "*Tubantia* torpedoed and lost, am now leaving ship with captain,



[*Photo: Photopress*

THE DUTCH LINER "TUBANTIA," OF 13,911 TONS. SHE WAS QUITE A MODERN SHIP.

do not worry." It was signed by the senior wireless operator. Another wireless message was received in Amsterdam from the captain, which made it clear that the torpedo struck the stern of the vessel, damaging the steering gear and admitting water to the corridors and engine room. The vessel, which remained afloat for about three hours, is represented in our illustration.

The Germans really seem to believe that "All is fair in love and war," for, after the torpedoing of the *Tubantia*, a wireless message was received at Flushing saying "*Tubantia* struck a mine." The captain of the vessel sent no telegram to this effect, so that, apparently, the submarine which torpedoed the vessel sent it.

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SINKING OF THE "CLAN MACTAVISH."

In connection with the sinking of the above vessel we are now enabled to publish a photograph of her, together with the gallant commander who put up so brave a fight against such terrible odds.

* * * * * *

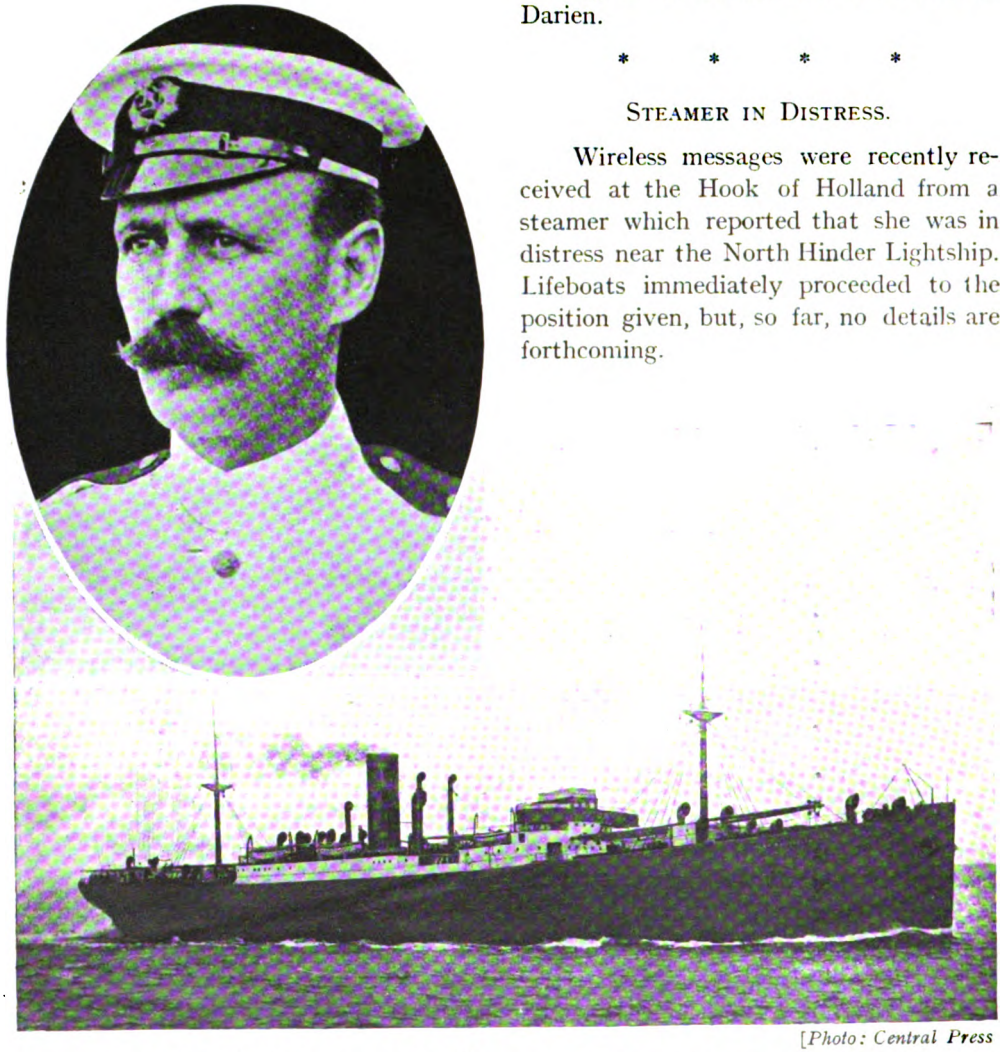
JAPANESE STEAMER MISSING.

The Japanese steamer *Hokoku Maru*, of 5,038 tons, has been posted for inquiry at Lloyds as being very much overdue. The steamer left Singapore for Durban, bound from Portland (Oregon) for the United Kingdom, and a wireless message was received at Sabang (Dutch East Indies) two days later. She was built at Greenock in 1895 as the *Sunda*, and was owned at Darien.

* * * *

STEAMER IN DISTRESS.

Wireless messages were recently received at the Hook of Holland from a steamer which reported that she was in distress near the North Hinder Lightship. Lifeboats immediately proceeded to the position given, but, so far, no details are forthcoming.



[*Photo: Central Press*

THE S.S. "CLAN MACTAVISH," WHICH WAS SUNK BY THE GERMAN RAIDER "MOEWE" IN THE ATLANTIC AFTER BRAVELY RESISTING. INSET: CAPTAIN OLIVER, HER PLUCKY COMMANDER.

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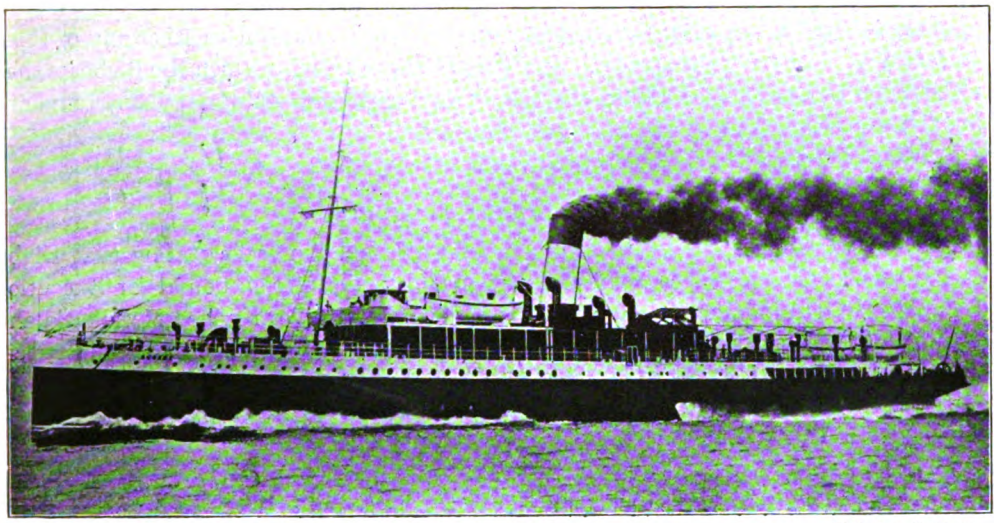

[*Photo: L.N.A.*

THE CROSS-CHANNEL STEAMER "SUSSEX," TORPEDOED AND SUNK BY A GERMAN SUBMARINE, UNFORTUNATELY WITH LOSS OF LIFE.

Sinking of the s.s. "Sussex."

Germany's record of crime will stain her character to the end of all time. The chivalry of the sea, which forms the heritage of all maritime nations, is strangely lacking on the part of our Continental enemy. Germany's depraved methods of warfare have again been emphasised in the sinking of the cross-Channel steamer *Sussex*. The ship was unarmed, and thus a very strong lever is put into the hands of the President of the United States in dealing with the incident from an American point of view.

It transpires that the force of the explosion caused by the torpedo dismantled the wireless apparatus, but the crew succeeded in rigging up a temporary one, by means of which calls for assistance were sent out and were picked up on both sides of the Channel. Vessels at once put out to the rescue from Folkestone and Dover, and from the French Channel Ports, and were quickly on the scene. Unfortunately several lives were lost, but this discredit only adds to those already laid to the charge of the "All-Highest Wilhelm."

* * * * * *

Crack Cargo Boat Lost.

The s.s. *Palembang*, of 6,674 tons gross, and trading between Rotterdam, London and Java, was sunk near the Galloper Buoy recently. It has not been determined whether she was sunk by a mine or torpedo. As far as can be ascertained no one saw any trace of a submarine. The only steamer in the neighbourhood at the time was the Dutch collier *Merak*, which passed, homeward bound, a quarter of an hour before the *Palembang* sank, and was apparently not in a position to render assistance. The wireless operator on board the *Palembang* sent out a call for assistance, which was answered about one hour later by a British torpedo boat; she discovered the lifeboats and took the crew into Harwich. The ship sank within a quarter of an hour of the accident, but, fortunately, all on board were saved with the exception of one man, a

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Javanese. Had it not been for wireless telegraphy it is doubtful whether any of those on board would have been saved, as, owing to the celerity with which the lifeboats had to be launched, several of them were badly damaged and could not have remained afloat for a very long period.

* * * * * *

STEAM TENDER FOUNDERS.

From Vancouver, British Columbia, comes a Lloyd's message stating that Digby Island reports by wireless that the Cannery steam tender *Alpha*, bound for Execution Bay, Alaska, had foundered off Ratchell Island. One survivor reached Metlakatla and reports that the remaining five of the crew were swimming with lifebelts when last seen.

* * * * * *

ACTION OF THE DUTCH.

In connection with the danger arising from mines and torpedo craft in the North Sea the question is being considered in Dutch Government and shipping circles of using tugboats equipped with wireless telegraph apparatus and appliances for rescue work to convoy Dutch liners. The whole question is one of serious moment to Dutch shippers and shipowners and calls for immediate settlement.

* * * * * *

CAPTURED BY THE "MOEWE."

The following letter descriptive of the sinking of the s.s. *Flamenco* by the notorious German pirate *Moewe* is published by our contemporary *The Syren and Shipping*; it admirably illustrates the value of wireless telegraphy in these times and the fear with which it is regarded by the enemy :—

"At Sea, February 26th

"I suppose by this time you have heard of the loss of my ship, but perhaps not all "the details. On February 6th, at 8.30 a.m., I noticed a steamer on my port beam "steering in the same direction as myself, but a little more to the west. She looked "rather like an intermediate P. and O. steamer, so I just stayed on the bridge watching "her. She was closing in rapidly, and I thought her intention was to go under our "stern. When she was about 300 yards away, her bulwarks opened and I found "myself looking into the muzzles of two big guns. At the same time a shot was fired "across the bow and the signals 'Stop immediately' and 'Don't use your wireless' "were hoisted up, accompanied by the German naval ensign. I immediately com- "menced to send out wireless messages. Then the fun began; they sent five "shots into me, one right under the bridge, covering me with dust, rust and bits of "wood; the others, one after the other, into different parts of the ship, wounding three "of my men and killing my dog. I naturally thought they intended to sink my ship by "gunfire, so ordered the crew to their boat stations and then went to my cabin and "destroyed all Admiralty correspondence. My boats were then away from the ship, "and I found myself left alone, but all firing had stopped. The boats from the Germans "came alongside and took me off, as the ship was then in flames, so they got nothing "out of the ship. They were mad when they found there was nothing.

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" On arrival on board the *Moewe*, the Captain (Count von Donah) sent for me and " asked me why I had used my wireless against his orders. I told him I did so because " it was my duty to do so. He then said: ' It was my duty to destroy you as you were " placing my ship in danger.' I said I quite expected to be killed by the way they " were going about it, but that I was not allowing the thought of that to stop me. He " then held out his hand and said: ' You did right, and I would have done the same.'

" One thing of interest. On arrival of the *Moewe* I passed a German sailor sitting " on an upturned case on which was written in plain letters ' *Clan*, G. R. Mackenzie " (Glasgow), Limited.'

" P.S.—I was sunk off Fernando Noronha."

* * * * * *

SAVING OF S.S. " POLLENTIA'S " CREW.

Public opinion has been deeply impressed by the news lately published in the press concerning the saving of all persons on board the British steamer *Pollentia*, effected by the Italian steamer *Giuseppe Verdi* under extremely difficult circumstances, mention of which was made in the March issue of THE WIRELESS WORLD. All testimonials agree upon the fact that the crew of the s.s. *Pollentia* owe their safety to the Marconi wireless telegraph service and to the perfect organisation for transoceanic wireless communication established by the Marconi Company.

In fact, when, on January 19th last, the s.s. *Pollentia* sent out her call of distress she was lost in the middle of the Atlantic Ocean, considerably out of the beaten route of other vessels. The s.s. *Giuseppe Verdi* picked up her call and changing her route according to the wireless indications received from the s.s. *Pollentia*, was able, after two days of anxious and tragic search, to approach the sinking vessel and so save all human lives on board.

The Rome Office of the Marconi Company has received many congratulatory letters from all quarters, and we are now pleased to publish two of those letters, one from the Italian Ministry of Posts and Telegraphs, and the other from the Transatlantica Italiana Steamship Company, owners of the s.s. *Giuseppe Verdi*, speaking in glowing terms of the splendid services rendered by wireless telegraphy to humanity.

" Ministry of Posts and Telegraphs.

" ROME, *March 3rd*, 1916.

" To the Marconi Company, Rome.

" DEAR SIRS,—I have read with great interest and deep satisfaction the abstract " of the P.V. concerning the saving of the British steamer *Pollentia's* crew, effected by " the s.s. *Giuseppe Verdi*, and made possible by the exchange of wireless messages " between the two steamers, under most difficult circumstances.

" By this well deserving feat maritime wireless telegraphy adds a new achievement " to the countless services already rendered to humanity by the genius of Guglielmo " Marconi.

" Allow me, therefore, to join my share of praise to the Company that has organised " the maritime wireless telegraph service and to their bold and able operators.

" For the Minister,

" (Signed) DURAN."

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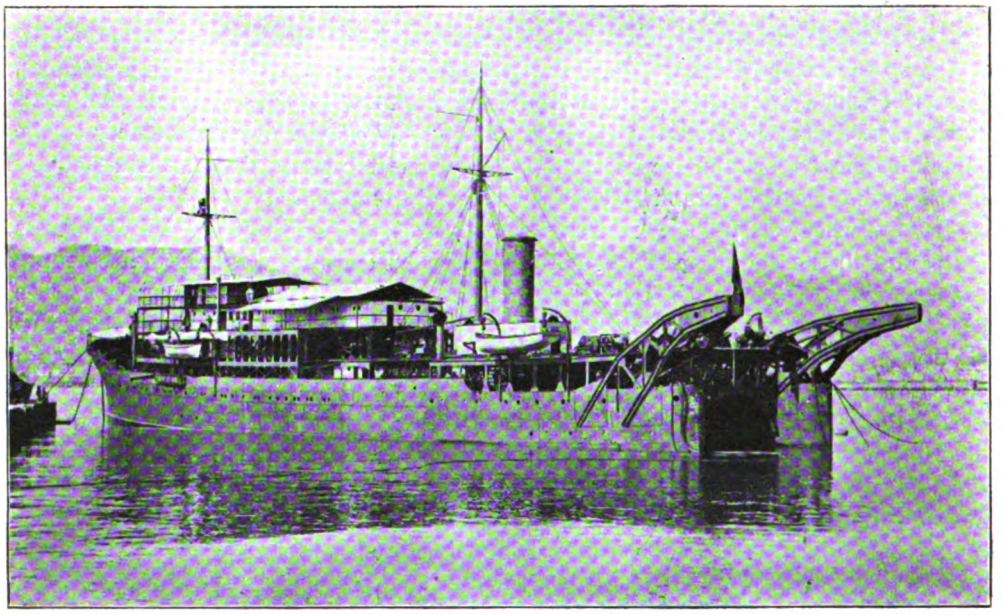
" Transatlantica Italiana. " GENOA, *February 9th*, 1916.

" To the Marconi Company,
" Rome Office, Rome.

" DEAR SIRS,—In the name of the Transatlantica Italiana, I am pleased to inform " you that, on the occasion of the saving of the crew of the s.s. *Pollentia* (flying the " British flag), effected by our steamer *Giuseppe Verdi* in the northern part of the " Atlantic Ocean (lat. 46.52 N. and long. 28.34W.G., on January 23rd, 1916), the " ' Marconi telegraph ' proved to be not only of inestimable benefit, but it has been " ascertained that, without this wonderful invention, due to an Italian, the crew of " the s.s. *Pollentia* could not have escaped a certain death.

" The Chairman
" (Signed) VENCESLAO CARRARA."



[*Photo by the Courtesy of "Engineering."*

THE NEW BRAZILIAN SUBMARINE DEPOT SHIP " CEARA."

NEW SUBMARINE DEPOT SHIP.

By the courtesy of the editor of *Engineering* we are enabled to publish a photograph of the new Brazilian Diesel-engine-propelled submarine depot ship *Ceara*. She was built for the Brazilian Navy to act with the submarine flotilla of that country, which comprises several submarines of the Laurenti type, constructed by the builders of this depot ship. As armament the *Ceara* has 8 guns, 4 of 3·937 inches and 4 of 2·244 inches calibre. Her chief characteristic is that the afterpart is constructed in the form of a floating dock, which can accommodate one of the units of the submarine flotilla, and this is well shown in our illustration. Extra accommodation is provided on board for the crews of six submarines, about 130 all told. She is fitted with wireless telegraph apparatus and represents the latest practice in Diesel engine work.

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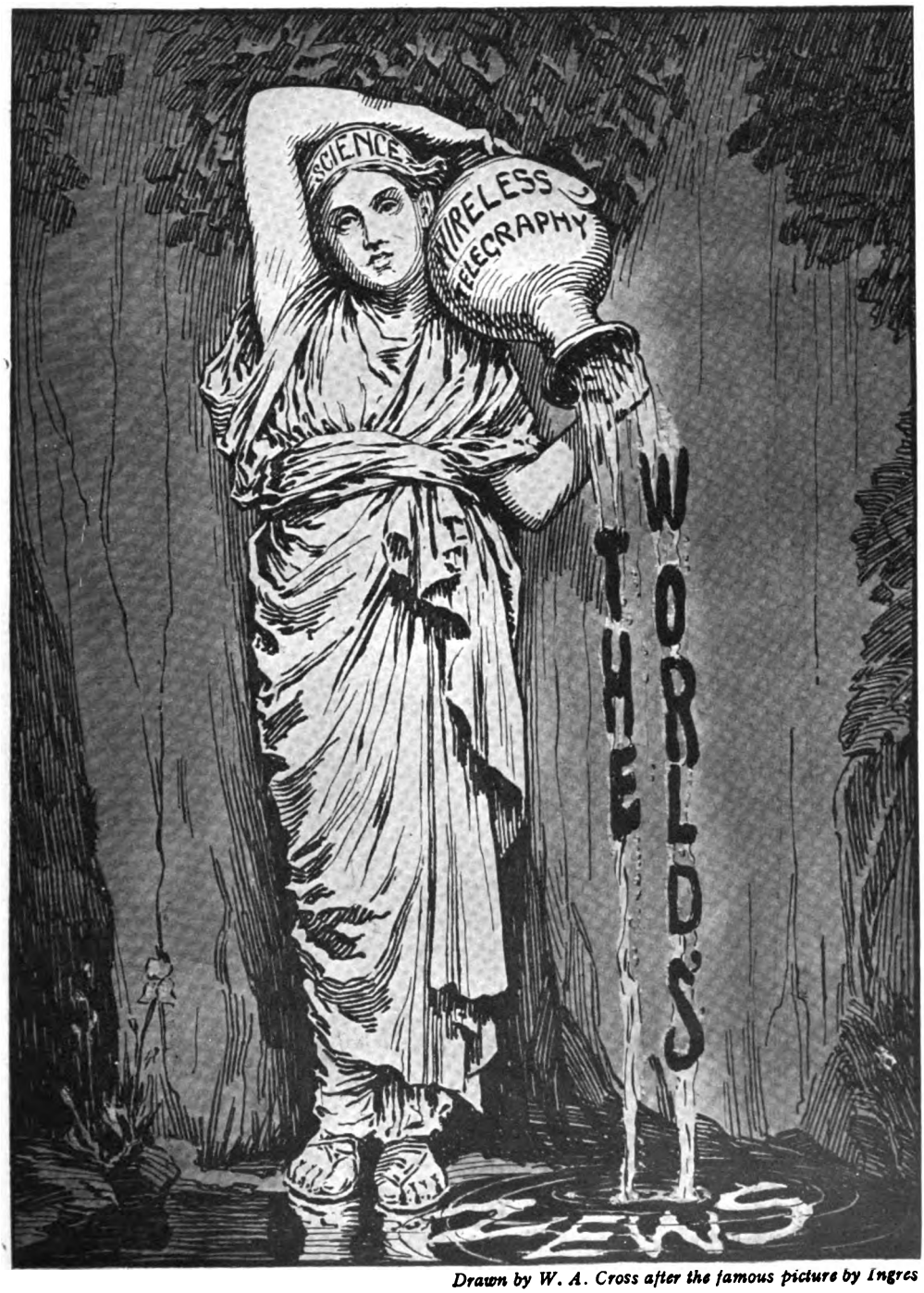

Drawn by W. A. Cross after the famous picture by Ingres

LA SOURCE (A PROPHECY)

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Oscillating Circuit Calculations

By SAMUEL LOWEY

THE formula usually made use of in finding values of CL for oscillating circuits is :—

$$\lambda = 600\pi\sqrt{CL}, \text{ or approximately } 1885\sqrt{CL}$$

when λ = wave-length in metres, C = capacity in microfarads, and L = inductance in microhenries.

It is not difficult to work from this formula, but it is convenient to have values of CL for different wave-lengths ready worked out.

The values of CL for wave-lengths from 1,000 to 10,000 metres are given on the spiral scale, Fig. 1, which, being of considerable length, enables one to read to about four significant figures.

In the numbers on CL scale two decimal points are shown : the one to use is the one nearer to the wave-length scale which is being read ; thus, for 1,385 metres, $CL = \cdot 54$, while for 4,380 metres, $CL = 5 \cdot 4$.

The λ scale may be divided by any power of 10, providing that the CL scale is divided by the same number squared.

To avoid errors when doing this, a coarse scale of large range has been added immediately below the spiral scale.

The complete formula, which takes into account the resistance (R — ohms) of the circuit is :

$$\lambda = \frac{600\pi}{\sqrt{\frac{1}{CL} - \frac{R^2}{4L^2}}}.$$

In the majority of cases, when the resistance is low, the error produced by neglecting the resistance is exceedingly small ; but in certain cases, even with low resistance, the amount of the error assumes large dimensions.

To give an example : In a circuit having capacity $\cdot 1$ microfarad and inductance 1 microhenry, the wave-length from scale would be 596·1 metres.

If the resistance is 1 ohm, 1·3 per cent. has to be added to wave-length, while, if resistance is 2 ohms, the addition is 5 per cent. ; 5 ohms, 65 per cent. ; while the circuit loses its oscillatory property if the resistance rises as high as $6\frac{1}{3}$ ohms.

While this is a very extreme case and one not likely to be encountered, particularly by amateurs, it is desirable to have some means for finding what the amount of this error is

$$\frac{600\pi}{\sqrt{\frac{1}{CL} - \frac{R^2}{4L^2}}} \div 600\pi\sqrt{CL} \text{ gives the quantity } \frac{1}{\sqrt{1 - \frac{R^2C}{4L}}}$$

A curve of this quantity, Fig. 2, is given corresponding to different values of $\frac{R^2C}{4L}$. In filling in values of R, C, and L only very approximate numbers need be used.

In a circuit having $L = 1{,}000$ microhenries, $C = \cdot 0001$ microfarads, $R = 200$ ohms

$$\frac{R^2C}{4L} = \cdot 001. \quad \text{The value of } \frac{1}{\sqrt{1 - \frac{R^2C}{4L}}}$$

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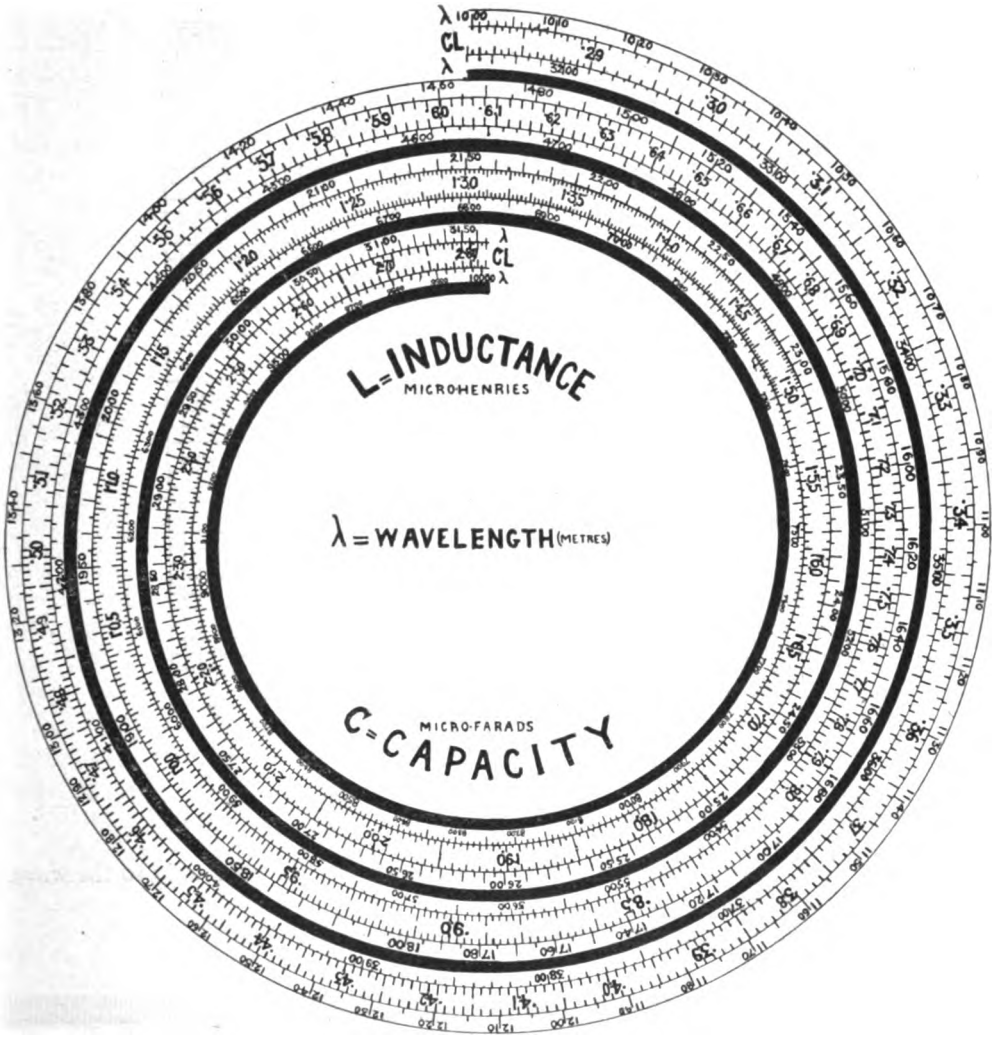

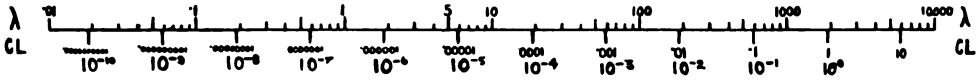

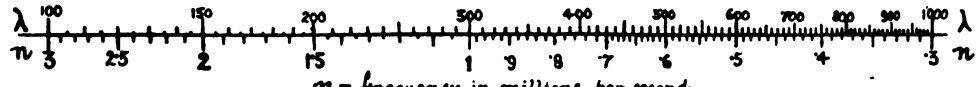
λ
n
n= frequency in millions per second
λ scale may be multiplied by any power of 10, providing that n scale be divided by same number

FIG. I.

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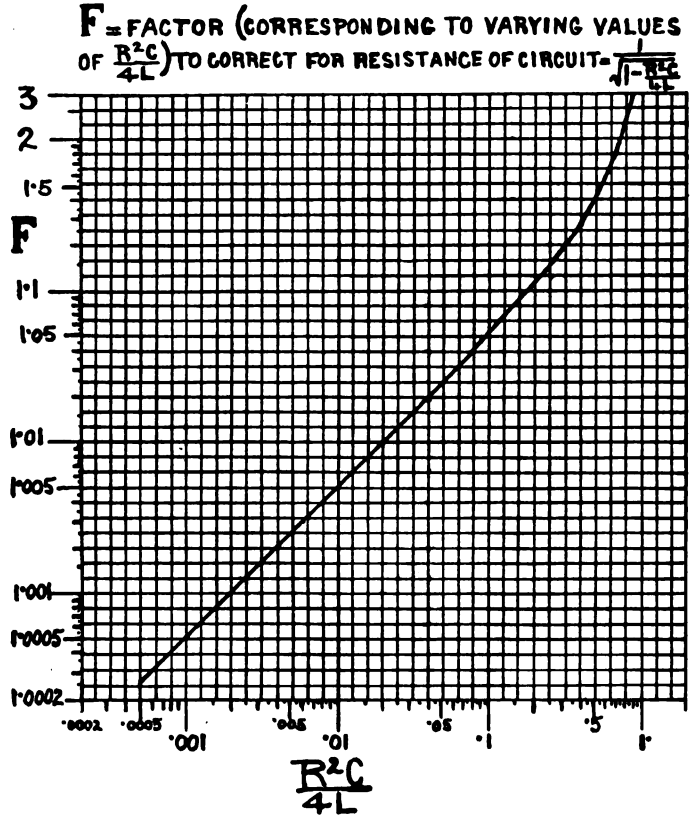

FIG. 2.

(F from curve) is 1·0005, which means an addition of ·05 per cent. only to the wave length as read from scale.

An amount such as this can be neglected usually.

Corps of Royal Engineers (Wireless Section)

We understand more officers are required for the above branch of the service. Candidates should forward their applications to Major A. Handley, R.E., O.C. Wireless Training Centre, St. Martin's Gate, Worcester. It is essential that candidates should have a thorough knowledge of the theory and practice of wireless telegraphy; and in sending their applications candidates should state fully their training and experience, and whether they have had any previous military service. The term of service will be for the period of the war, and successful candidates will be required to serve at home or abroad.

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Correspondence

DEAR SIRS,—With reference to a notice in the January WIRELESS WORLD under "Foreign and Colonial Notes," I must inform you that the wireless station opened at Lourenço Marques and three others erected in the Mozambique Province were offered to the Government of the Province by the Government of the Union of South Africa as a present, and not as payment for any services rendered.

The above station recently got communication with VND (Durban), 300 miles distant, which I think is a record for a ½-k.w. station, though it was during night time.

Yours very faithfully,

(Signed) DOMINGOS BARRETO.

Inhambane, February 9th, 1916.

[Mr. Domingos Barreto is the District Director of Posts and Telegraphs at Inhambane, Portuguese East Africa.—ED.]

* * * * * *

WIRELESS AT BOWES PARK.

OUR paragraph under the above heading in recent issues of THE WIRELESS WORLD has brought forth the following letter from a reader at Bishop's Waltham, in Hampshire:

"I am glad to find that someone else has had a similar experience to mine. On "the strength of my 'wireless' I was credited with several German relations, including "two nephews fighting in the German army.

"I had the usual visits from the police, but was able to satisfy them that these "relations did not exist, and since then have had no bother.

"I have never been able to trace the author of the libel, in spite of the offer of "a reward, but it will no doubt come out some day, and then he will be sorry for himself.

"Yours truly,

(Signed) "ARTHUR F. HARDY."

* * * * * *

ASYMMETRICAL TRANSMISSION PHENOMENA.

SIR,—I am very interested in the article on "Asymmetrical Transmission Pheno-"mena," which you published in the April issue of THE WIRELESS WORLD. Judging from some rough observations I made a few years ago, I believe that between Malta and Port Said there exists a small area where it is practically impossible to communicate with the Port Said station, although there is no intervening land whatever, and signals are easily exchanged at a much greater distance. Perhaps some operator who is well acquainted with this part of the Mediterranean may be able to furnish detailed particulars, as all such information is welcomed by investigators and often serves a very useful purpose in solving radiotelegraphic problems.—Yours, etc.,

"REDAX."

London

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WIRELESS IN THE TROPICS.

SIR,—An article in your February number regarding "Wireless in the Tropics" is just to hand. Practically the same results were observed by me while cruising up the Econdido River in Nicaragua, in 1912. I was told to keep in communication with the station at Bluefields, but upon entering the river six miles from the station and until our return no communication was possible.

My normal daylight range was 350 miles. The equipment consisted of an independent steam engine, generator (2 kw.) alternator, and air compressor. The intervening land was low, swampy, and covered with a heavy tropical forest, and, so far as could be ascertained, there were no mineral deposits.—Yours, etc.,

P. S. BERRY.

(*Superintendent of Wireless Telegraphs, Belize, British Honduras.*)

Richmond Royal Horse Show, 1916

We have been asked to make known that the Richmond Royal Horse Show will this year be held in aid of the Fund of Queen Mary's "Star and Garter" Hospital and Home for paralysed and totally disabled sailors and soldiers. The show will take place on June 16th and 17th. It is the intention of the Directors to devote this year's entire profits to endow and name a room in the Home. One or two gifts of animals have already been made by generous donors, and we trust that some of our readers may be able to help this worthy object, if only by their presence at the show.

By the courtesy of the "Passing Show."]

TRANSATLANTIC WIRELESS TELEPHONY.

BRITISH EDITOR: "Hullo! Is that New York? Will you be good enough to let us have the latest news about our war, please?"

* * *

THE MEXICAN REVOLUTION.

Wireless telegraphy is being extensively employed by the United States Army in Mexico, wireless telegrams constantly passing between Army headquarters at El Paso, Texas, and the Front.

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Among the Operators

THE LATE OPERATOR ANDERSON

Death through Pneumonia.

We regret to announce the death from pneumonia of operator John Anderson. Mr. Anderson, who was the wireless operator upon the Ellerman liner *Koranna*, was taken ill at sea and, after being taken ashore at Durban, died in hospital there on March 24th. A native of Fraserburg and in his twenty-first year, the late gentleman's service in the Marconi Company dated from January, 1915. Previous to joining the *Koranna* he saw service upon the s.s. *Menominee* and the s.s. *Glenlogan*. We offer our sincerest sympathy to Mr. Anderson's parents in their sad bereavement.

* * * * * *

Auxiliary Ship Sunk.

In the list of survivors of His Majesty's Mercantile Auxiliary *Fauvette*, which struck a mine off the East Coast and sank, we are pleased to find the name of Mr. E. Rogers, wireless operator.

* * * * * *

Saved from Captivity.

The Admiralty has announced the list of officers and men of H.M.S. *Tara* who survived the loss of the ship, and, after being captured by the Senussi, were rescued from captivity. This includes Mr. Robert Neil, warrant telegraphist, R.N.R., and C. W. Birkby, wireless telegraphist. Both men are to be congratulated upon their rescue from the hands of such fanatical enemies.

* * * * * *

The Shelled Liner "Englishman."

The shelled *Englishman*, which our readers will remember was sunk on March 24th, carried two wireless operators—M. Longworth Dames and J. C. Crawford. Both of these gentlemen were fortunately saved. Mr. Dames, who is 19 years of age, is a comparatively new recruit to the Marconi Service, having joined in January, 1915. A native of Bath, he received his education at King's School, Worcester, and, taking an interest in wireless telegraphy, underwent a course of wireless instruction at the London Telegraph Training College. Upon receiving his appointment to the Marconi Company's staff, he proceeded to

OPERATOR M. L. DAMES

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OPERATOR J. C. CRAWFORD

sea upon the s.s. *Oxonian*, from this ship transferring to the s.s. *Ghazee*, and thence to the *Makarini*. At the time of the disaster he had already served nearly five months upon the *Englishman*.

The junior operator, Mr. John Crawford, is a native of Ayrshire, and is 19 years of age, He was educated at Dalry School, Ayrshire, and received his preliminary wireless training at the North British Wireless Schools, Glasgow. Joining the Marconi Company in October, 1915, he was appointed to the *Englishman* as his first ship. Both of these gentlemen are none the worse for their exciting adventure.

* * * * * *

A TRUE WIRELESS HERO.

In the Christmas number of THE WIRELESS WORLD we announced the death of Mr. Arthur Henry Dews, wireless operator of the torpedoed liner *Marquette*. We have now had the opportunity of perusing a letter sent by Captain David N. Isaacs to the parents of the late Mr. Dews, from which it appears that the ill-fated gentleman met his death under circumstances of the greatest heroism. The whole wireless service will, we are sure, be thrilled with pride upon learning the facts given below. Captain Isaacs writes :—

"On that fateful day, your son, with several others, was seated on a raft when "I reached it. It was only a very small raft, but within a few minutes about six "more men came along and hung on with me, making about twelve altogether. After "a few hours the intense cold began to tell on everyone, especially those with little "clothing on. Then the trouble started. We put those suffering the most on to "the raft, three of the men being quite helpless. It was whilst pushing one of my "own unit on the raft, after he had fallen off "three times, that I noticed your son slip off the "raft on the other side. He had got off to "make room for the others. I swam round his "side, and he said he was all right and smiled "bravely. The sea was getting rougher and it "was a terrible job to keep the raft from turning "over. One man fell off and drifted away before "he could be caught. Big pieces of wreckage "came along and several of the men swam to these.

THE LATE OPERATOR A. H. DEWS

"Your son, seeing what difficulties we were "in, though suffering intensely from the cold, "thought it would be better if he could pick up a "piece of wreckage, and swam just a few "yards to a fairly large piece. I watched

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"him get perched safely on to that, and he still seemed quite able to "stick it.

"I regret I cannot tell you much more as my efforts to keep our raft right side "up occupied all my time from then on, as it meant certain death to at least four of "those still on it. I had contracted a severe cramp myself, and so crawled on to the "edge of the raft about five hours after, just getting to it. From where I was I could "look around, and, after a while, I could pick out your poor lad sticking to his board "gamely, but he gradually got out of sight and I saw him no more. I have made "every inquiry from our men, but no one can tell me anything. He left no message "that I know of, as he apparently had no thought of giving in. I feel positive his end "was due to exposure. There were three ships rescuing the survivors, and it was not "until the next day that I found that he was amongst the missing.

"I can only add that my deep-felt sympathy goes out to you all in your great "loss. A sadder or more painful task could never be set anyone than to have to write "such a letter as this, but if your sorrow is lessened, even a little, by the knowledge "that your poor son gave his life for the great cause in such a noble manner, I shall "feel more than repaid."

* * * * * *

An Heroic French Operator.

In connection with the sinking of the *Provence II.* we have culled a report, the following of which is a translation, from the *Echo de Paris* of March 20th :—

"A man living at Havre, who was fortunate enough to escape from the wreck of "the *Provence II.*, gives moving details of the heroism of the wireless operator on "board. This operator, named Joseph Huby, and who comes from a village near "Lorient, stuck to his post until he was drowned. When the torpedo struck the "vessel, Huby sent the SOS distress signal and continued to do so, without an "interval, the whole time the ship remained afloat. The torpedo struck the boat "and the stern sank rapidly into the water, but Huby still remained seated before his "instrument, energetically working the key. He remained there alone. The "passengers had made their way to the fore-part of the ship, which was gradually "rising out of the water; in fact, the acute angle to which the ship was gradually "attaining threw them off their feet. A large number of them precipitated themselves "into the water. Whilst all this was going on forward, Huby, in his cabin, continued "to send out his desperate appeal, until the water reached him. At this point the "fore-part of the ship rose suddenly, until the *Provence II.* was vertical in the water. "Then, with fearful rapidity, she disappeared, engulfing with her the brave "telegraphist whose prompt action was instrumental in saving those who succeeded "in escaping."

* * * * * *

The North Sea Fight.

Among the list of those killed in the engagement between H.M.S. *Alcantara* and the German raider *Greif* we regret to find the name of wireless telegraphist operator James Beckett, R.N.R. Mr. Beckett, who volunteered for active service in the first days of the war, is a native of Gillingham, Kent, and is an ex-Post Office man. He joined the Marconi Company's London School in April, 1913, and, after completing

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his training, joined the s.s. *Amazon* in May of that year. He afterwards served on the s.s. *Sardinia*, *Sicilian*, *Maryland*, *Rappahannock* and *Corinthian*, serving for three voyages on this last ship. As mentioned above, he volunteered for active service in August, 1914, and, in due course, was appointed to the *Alcantara*.

We take this opportunity of expressing our deep sympathy with the relatives of the late Mr. Beckett in the terrible loss which they have sustained.

THE LATE OPERATOR J. BECKETT, R.N.R.

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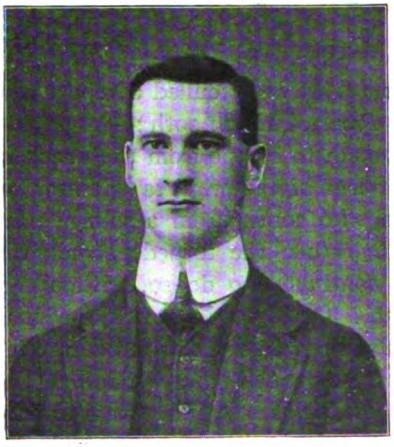
THE LOST "MINNEAPOLIS."

This ship, one of the largest of the sub-marine victims of this war, carried two operators, Messrs. T. F. O'Halloran and George Petrie. The senior operator, Mr. O'Halloran, makes his home at Tralee, Ireland, and is 25 years of age. He was educated in his native town, and entered the Marconi Company's London School in May, 1913. After completing the course of instruction he was appointed to the s.s. *Ausonia*, and afterwards served on the s.s. *California*, *Mumari*, and a number of other vessels. He was appointed to the *Minneapolis* in December last, and, we are glad to say, received no injury when that vessel was sunk.



OPERATOR O'HALLORAN

The junior operator, Mr. George Petrie, is a Scotsman, having been born in Dundee in 1894. He received his preliminary wireless training at the North British Wireless Schools, and proceeded to London for his final training at Marconi House in November, 1915. The *Minneapolis* was his first ship, and he also came through the exciting experience with no injury.

OPERATOR G. PETRIE

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Some Interesting Signalling Devices

A REPRESENTATIVE of THE WIRELESS WORLD recently had an opportunity of inspecting a number of very interesting devices placed on the market by Messrs. Graham & Latham, Ltd., military engineers, of 104, Victoria Street, Westminster, S.W., for use in Morse signalling on land and sea. To those unacquainted with military and naval requirements the number of different signalling instruments in use at the present day is liable to create considerable surprise.

Messrs. Graham & Latham were one of the first firms to realise the advantages of specially designed dry batteries in combination with metallic filament bulbs for flash signalling purposes, and they have now produced many highly efficient and readily portable sets, which, we understand, have been taken up in large numbers by the authorities. One of the most ingenious forms of signal lamp made by this firm consists of a small fitting placed inside the barrel of a rifle, signalling being effected by a switch attached to the trigger. When the signaller wished to communicate with some point he aims the rifle containing the lamp at the point at which the corresponding signaller is situated. The great advantage of this arrangement is that the enemy cannot possibly intercept the signal, for the dispersion of the light even at considerable distances is very small, and the signal can only be seen directly in the line along which the rifle is aimed. Signals from this rifle Morse lamp have been read with the naked eye up to 800 yards at night, and with a telescope at twice this distance. At three-quarters of a mile tests have shown the lateral dispersion to be but four yards.

Another useful signal lamp made by this firm is the "Chapman," in which the projector, tripod, key, battery and reading lamp are all separate and detachable units, each contained in a convenient leather wallet for carrying on the waist-belt.

For disc signalling Messrs. Graham & Latham, Ltd., have placed upon the market a greatly improved form of disc, capable of manipulation at a much higher rate of speed than the older model, and, at the same time, being of strong although light construction.

In buzzer sets, for use either for practice or for signalling along a telephone wire, this company have specialised for some time, and they have just produced a new tunable buzzer which should find many purchasers. For those who require practice with lamp as well as buzzer a combined set has been produced to give signals by both audible and visual methods.

Another novelty recently produced by this firm is the dummy sounding key, which gives signals like those of a Post Office sounder and serves as an excellent means of learning this form of reception at a very small cost.

Space will not permit us to deal with many of the other signalling instruments obtainable from this enterprising house, but we must not omit mention of the Electric Mast-head Morse Lamp Portable Equipment, comprising a water-tight teak case, having a powerful dry battery and a lamp with 40 feet of rubber flex and plug attached, spare bulb, and Morse key arranged for operating with lid either open or closed. The total weight is but 15 lb., and the dimensions 10 by 6 by 8 inches.

Readers who are interested in the above devices are advised to write to Messrs. Graham & Latham, Ltd., for their Signalling Catalogue and Electrical Supplement, the fifth edition of which is now ready and obtainable post free upon request.

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A Hero of the Service

Magnificent Upholding of the Marconi Tradition

By the courtesy of Messrs. Elders & Fyffe, Ltd., we are able to publish a copy of a protest made in due form before a Notary Public by the master, third officer, and two members of the crew of the torpedoed steamship *Zent*, which was attacked without the slightest warning by a German submarine. This protest contains a vivid description of the last moments on board the liner and of the magnificent heroism of the operator, Mr. Proughten, who lost his life at the post of duty. We do not think we can do better than publish this document exactly as it stands.

"BY THIS PUBLIC INSTRUMENT OF PROTEST, Be it known and made "manifest unto all people to whom the same shall come that upon the Seventh day of "April one thousand nine hundred and sixteen personally appeared before me, Atwell "Hayes Allen, Notary Public, George Ernest Martin, master of the late steamship "or vessel *Zent*, and noted protest, and again on the Seventh day of April in the year "of our Lord one thousand nine hundred and sixteen before me the said Atwell Hayes "Allen, Notary Public, duly authorised, admitted and sworn, residing and practising "at Queenstown, in the County of Cork, in that part of the United Kingdom of Great "Britain and Ireland called Ireland, personally appeared the said George Ernest "Martin, master of the steamship *Zent* of Belfast of the burthen of 2,485 tons register, "and also at the same time and place personally appeared, came and appeared Archibald "Robertson Gibbons, third officer, Charles Crosby, cook, and Albert Coleman, fireman, "being lately all of and belonging to the said vessel who did severally duly and solemnly "declare and state as follows that is to say :—

"That the said vessel sailed from Liverpool on the 4th day of April inst. bound on "a voyage from thence to Santa Marta, Colombia, in ballast, the said vessel being then "tight, staunch and strong, well manned, victualled and found, and in every respect "fit to perform her said intended voyage. The weather was fine and they proceeded "down the Channel without anything of "importance occurring until they were about "28 miles S.W. of the Fastnet light, at 10.20 "p.m. on the 5th of April; they had no "lights burning, the night was dark and "clear, the moon had set, the sea was smooth "with westerly swell, and the vessel pro- "ceeding about 13½ knots, the course being "S. 54 W. true. The appearer, Archibald "Robertson Gibbons, third officer, being on "watch and a careful look-out being kept. "Nothing was observed until suddenly at "the hour mentioned a terrific explosion "occurred at the starboard side of the vessel, "occasioned by a torpedo striking the vessel. "It practically blew the side out of the

THE LATE OPERATOR PROUGHTEN.

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" ship and immediately afterwards a second torpedo struck the vessel abreast of " No. 3 hatch, also on the starboard side, and the vessel promptly foundered and had " completely disappeared in about two minutes from the first explosion. On the first " torpedo striking the vessel, the wireless operator, Mr. Proughten, at once proceeded " to his station and sent out the distress call SOS, giving the position of the vessel by " the emergency set of instruments, as the first torpedo had destroyed the dynamo of " the ordinary apparatus, and Mr. Proughten was never seen again, but appearers " have ascertained that he succeeded in sending the call before the ship foundered, " and the brave gentleman's life was sacrificed to his duty and by his self-sacrificing " devotion to duty he was the means of calling the assistance by which the survivors " were saved. They got three boats down to the water, but the vessel retained her " speed and foundered so quickly that the three boats capsized and all the occupants " were precipitated into the sea They remained clinging to wreckage and to the " upturned boats for about 2½ hours and those who survived were picked up by a " British naval patrol boat, and of a crew of sixty all told only the four appearers " and seven other were saved. Two bodies were picked up and brought to Queenstown " and buried. Nothing whatever was saved from the vessel.

" And these appearers do protest, and I, the said Notary, do also protest against " the aforesaid murderous outrage and occurrences and all loss and damage occasioned " thereby.

" We, George Ernest Martin, Archibald Robertson Gibbons, Charles Crosby and " Albert Coleman do solemnly and sincerely declare that the foregoing statement " is correct and contains a true account of the facts and circumstances, and we " make this solemn declaration conscientiously believing the same to be true and " by virtue of the provisions of the Statutory Declarations Act, 1835.

" (Signed) G. E. MARTIN, *Master.*
" (Signed) A. R. GIBBONS, *Third Mate.*
" (Signed) C. O. CROSBY, *Chef.*
" (Signed) A. COLEMAN.

" Thus declared and protested in due form of law at the office of me the said " Notary at Queenstown on the day and year hereinbefore written.

" (Signed) ATWELL H. ALLEN,
" *Notary Public,*
" *Queenstown.*

" SEAL."

Mr. Proughten belongs to East Finchley, and was in his twenty-eighth year. He was educated at Finchley, and joined the Marconi Company's London School in October, 1913. Upon completing his training, he was appointed to the s.s. *Ascania*, later being transferred to the s.s. *Den of Ewnie.* From this ship he proceeded to the *Antillian*, and was appointed to the *Zent* in April, 1915. He was on his fourth voyage on this vessel when the disaster occurred.

From the "Globe."

" In the matter of wireless telegraphy England easily comes first." Rule, Britannia: Britannia rules the air-waves.

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The Action of Crystal Detectors

By F. Basil Cooke, F.R.A.S.

In wireless literature there has, perhaps, been more said on the subject of detectors than on any other part of the wireless plant, and yet it is very hard to get just the information required.

This article on crystal rectifiers is written in the hope that it may be of some interest and use to experimenters. Nowadays, as the amateur is deprived of his set and cannot carry out the practical part of his researches, he cannot do better than learn all about the why and wherefore of what is to him an established fact. The writer has studied the subject of crystal rectifiers for the past five years, and although it is not claimed that this article is in any way original as far as principles are concerned, yet it is hoped that readers will find something in it to ponder over.

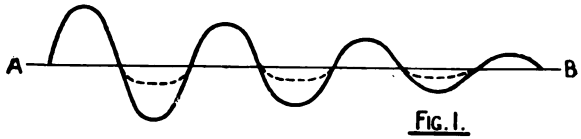

Fig. 1.

Everyone now in the wireless field knows that certain mineral crystals have the property of allowing a current to pass in one direction only—that is to say, they possess unilateral conductivity. The usually accepted theory of the working of a crystal is that the incoming current, being of an oscillatory character and of such great frequency that it will not affect a telephone receiver, has to pass through a crystal which blocks out half of the wave, only allowing the other half to pass. As this is equivalent to an intermittent continuous current the effect on the magnets of the telephone is cumulative, and consequently for each wave train, usually consisting of about 15 alternations, there is a pull by the magnets on the telephone diaphragm, giving a click.

This story seems to explain the phenomena to which we are all accustomed; but, in the opinion of the writer, there seem to be two reasons so vitally opposed to this theory as to completely condemn it. Before attempting a criticism it would be well briefly to review a few points about crystal detectors generally. In the first place, it appears to be generally accepted that the crystal detector is by far the most sensitive detector known, when handled by an expert. Secondly, we know that in the same crystal there are points very sensitive; although immediately adjacent there are places absolutely inert. Further, the chemical composition of a crystal does not play a significant part, and optically, physically, geologically and chemically there is no explanation for this curious fact. A tremendous amount of work has been done in connection with the unilateral conductivity of certain crystals, notably silicon and carborundum, and the results all show that in no single instance is a crystal a perfect rectifier. When a sensitive point is tried alongside of an inert one on the same crystal the difference in this unilateral conductivity is not nearly sufficient to account for the difference experienced from a wireless point of view. The pressure plays a very important part in the sensitivity of a point.

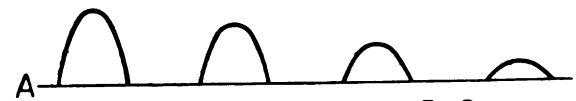

Fig. 2.

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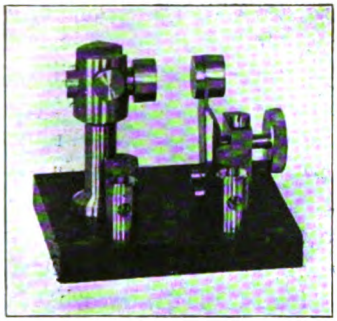

FIG. 3. A CARBORUNDUM CRYSTAL HOLDER IN WHICH THE CRYSTAL PRESSES AGAINST A STEEL PLATE

Let us now try and see why the accepted theory fails to account for the observed results. Imagine a crystal possessing perfect rectifying properties. Neglect the loss of current in all other parts of the receiving apparatus and consider the loss in the crystal itself. There are two great sources of loss—namely: (1) resistance, which is considerable; and (2) that due to the unilateral property of the crystal, which only allows half of the received current to pass. Of these the latter is the greater. We then see that, with a perfect valve and neglecting all other losses, we are only using one-half of the received current. If, on the other hand, as is the case in practice, the crystal is not a perfect valve, then there is considerably more loss. To explain this point, which seems to the writer to be of vital importance, we will glance at the usual diagram.

In Fig. 1 let *AB* be the axis of the curve. If there is no rectification the wave form is as represented in the figure. When we introduce a crystal the wave takes the form shown dotted, the top half remaining the same but the bottom half shortened. For perfect rectification the bottom half vanishes altogether, the top half being available for use in the 'phones. As, however, some of the current does get through in the reverse direction this will tend to neutralise the effect in the maximum direction and has to be subtracted, the final available current being shown in Fig. 2. It will be obvious at a glance what a small portion of the incoming wave can be utilised under this hypothesis. In the second place, the more perfect the rectification the greater should be the effect, but experiments fail to show such a result. Comparative tests have been made with a good Fleming valve detector and a good crystal, the result being most marked. In the case of the valve the rectification was very much more perfect than with the crystal, but the received signals from a station were very much better with the crystal than with the valve. This alone seems to give a flat contradiction to the usual theory.

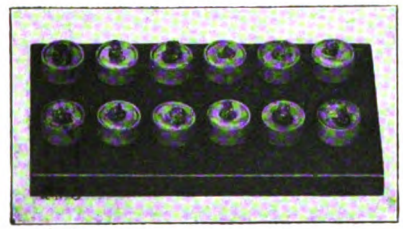

FIG. 4. MOUNTED CARBORUNDUM CRYSTALS FOR USE IN THE HOLDERS SHOWN IN FIGURES 3 AND 5

There are several detectors on the market which utilise much more of the wave than a valve can possibly do, and yet none of them is as sensitive. There seems to be little doubt that the true explanation for crystal working must embrace the fact that all of the received current is being utilised instead of about one-third.

From some experiments carried on at the Sydney University by Professor O. U. Vonwiller a likely

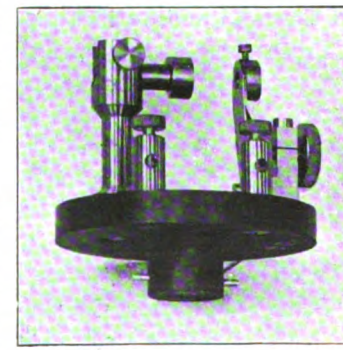

FIG. 5. ANOTHER FORM OF THE HOLDER SHOWN IN FIGURE 3. THIS IS MADE INTERCHANGEABLE WITH THE FLEMING VALVE

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explanation may be found from a thermal-couple effect. Without going into details, it seems to afford a satisfactory explanation for a number of the observed facts. In this case it will be obvious that all of the received current would be utilised in the form of heat and, owing to the poor heat conductivity of crystals, the heat would be localised at the point of contact, which, of course, is what would most naturally be required. It would then answer the question of why a sharp point is better than a blunt one, and why one metal point is better than another for a particular crystal. In conclusion, amateurs are strongly advised to try some experiments for themselves, and it is certain that, with a little pains, they will be well repaid for their trouble. Of course, while the war continues they cannot listen to signals, but what is to prevent them having a crystal and trying the unidirectional effect for themselves? All that is required is a sensitive galvanometer. Measurements of the deflection can be made in one direction and then, with the current reversed, in the other direction. Different voltages, etc., may also be tried. A graph should be made in each case so that the whole operation can be observed at a glance. There is a tremendous amount of very useful and fascinating work to be done in this direction, and now, while we are deprived of our aerials, is the time to do it.

Institute of Radio Engineers, New York

WE have just received a copy of the "Year Book" of this institution for 1916, than which no better evidence could be afforded of the excellent progress and manifold activities of this Society. A glance at the lists of membership shows a total of no less than 984, most of these being residents in the United States. England and Ireland can boast of 5 Fellows, 9 Members and 26 Associates, and, in view of the interest taken in wireless telegraphy by Germany, we are surprised to see that only 2 Fellows and 1 Member figure as belonging to that country.

The membership of the Institute consists of five grades: Honorary Members, Fellows, Members, Associates and Juniors. Among other advantages, all Members of the Institute are furnished, without extra expense, with copies of all issues of the "Proceedings of the Institute of Radio Engineers." Six issues of this are published per year, and the most recent developments and discoveries are clearly presented in its pages. Meetings are held monthly in New York, except during July and August of each year. At these meetings scientific, engineering, and other papers relative to the art of radio communication are presented by Members of the Institute specially qualified to treat the subject. As an example we may mention that on April 5th a paper by Dr. Louis W. Austen on "Experiments at the United States Naval Radio Station at Darien, Canal Zone," was read. A second paper by Mr. Bowden Washington, on "Some Small Direct Current Sets," was also to be read, time permitting.

We have also received the Institute of Radio Engineers' Report of the Committee on Standardisation for 1915, containing definitions of terms, tests and rating, standard graphical symbols, and definitions of trade names. This is a most useful and interesting publication to all concerned in wireless telegraphy.

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Instructional Article

NEW SERIES (No. 9).

The following series, of which the article below forms the ninth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

RELATIVE VELOCITY.

60. One very useful application of the vectorial method of calculation is its use in solving problems concerning relative velocities and accelerations.

In Fig. 41 let OA and OB be two straight railway lines, crossing at O. Imagine two trains travelling away from O, train OA travelling at 50 miles per hour, and train OB at 20 miles per hour. If we assume further that the two trains passed through O at the same time, then one hour later train OA will be at A—50 miles from O, and train OB at B—20 miles from O. Thus the distance between the two trains has increased, in one hour, from nothing (when they passed through O at the same time) to AB—to scale, 40 miles.

After the next hour the trains will reach A_1 and B_1, AA_1 being 50 miles, and BB_1 20 miles. It is obvious from the Fig. that A_1B_1 is equal to twice AB, or to 80 miles. Thus, during the second hour the distance between the trains has again increased by 40 miles (80–40) and so we see that the distance between the trains increases at the rate of 40 miles in each hour, OR the *speed of A relative to B* is 40 miles per hour in the direction BA (or B_1A_1 which is parallel to BA).

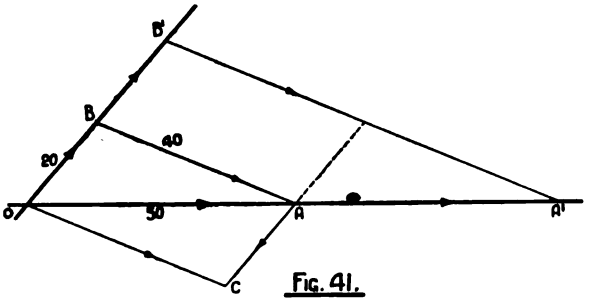

Fig. 41.

Now, by completing the parallelogram $OBAC$, we see that OC will give us the velocity of A relative to B, and OC is the result of the vectorial subtraction

$$OA - OB = OA + AC = OC.$$

Thus, to obtain the velocity of one moving point relative to a second moving point, we subtract vectorially the velocity of the latter from the velocity of the former.

Example.

The fly-wheel of a steam engine, 5 ft. in diameter, rotates at 120 revs. per minute. What is the average acceleration, during a quarter of a revolution, of a point on the rim?

The definition of acceleration is "rate of change of velocity." For example, if a train increases its speed from 30 miles per hour to 50 miles per hour in 5 minutes, the average acceleration during that 5 minutes is:

$$(50 - 30) = 20 \text{ miles per hour per 5 minutes;}$$

or $$\frac{20}{5} = 4 \text{ miles per hour per minute.}$$

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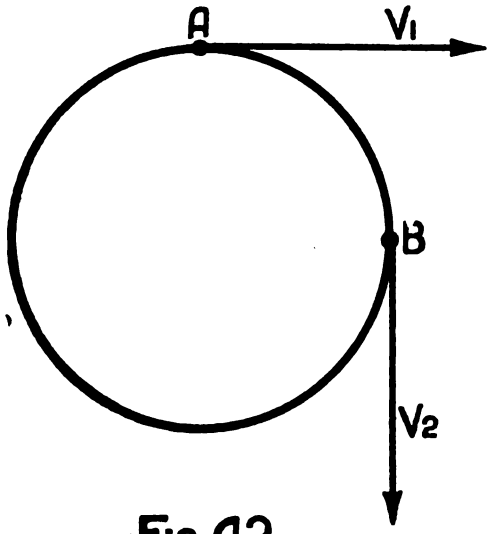

FIG. 42.

At first sight it would seem that a point on the rim of a fly-wheel which is rotating at a constant number of revolutions per minute would have no *change* of velocity, and therefore no acceleration. Referring, however, to Fig. 42, we see that during the transit from A to B the velocity has changed, not in *amount* but in *direction—i.e.*, from V_1 to V_2.

Thus, to get the acceleration we must find the value of $(V_2 - V_1)$, the *change* of velocity, and divide this value by the time occupied by the quarter revolution.

Now the point on the rim travels through 120 revs. per minute

$$= 120 \times \pi \times \text{diameter} = (120 \times \pi \times 5) \text{ ft. per minute}$$

$$= \frac{120 \times 5\pi}{60} = 10\pi = 31{\cdot}416 \text{ ft. per second.}$$

Let OP (Fig. 43) $= V_1 = 31{\cdot}416$ ft. per second.
OQ $= V_2 = 31{\cdot}416$ „ „
OR $= -V_1$

Then $OS = OQ + OR = V_2 + (-V_1) = V_2 - V_1$.

Now, obviously, since triangles OQS and ORS are right-angled triangles

$$OS^2 = OQ^2 + QS^2$$
$$= OQ^2 + OR^2$$
or OS $= \sqrt{OQ^2 + OR^2}$
$$= \sqrt{(31{\cdot}416)^2 + (31{\cdot}416)^2}$$
$$= \sqrt{2(31{\cdot}416)^2}$$
$$= (31{\cdot}416) \times \sqrt{2}$$
$$= 44{\cdot}4 \text{ ft. per second.}$$

Also angle POS is 135°, and so the *change in velocity* during the quarter revolution is $44{\cdot}4_{135°}$ ft. per second. Now 120 revolutions take 1 minute or 60 seconds; therefore, 1 revolution takes $\frac{1}{2}$ second, and $\frac{1}{4}$ revolution takes $\frac{1}{8}$ second.

Therefore, the average acceleration is $44{\cdot}4_{135°}$ ft. per second per $\frac{1}{8}$ second $= (44{\cdot}4 \times 8)_{135°} = 355{\cdot}2_{135°}$ ft. per second per second.

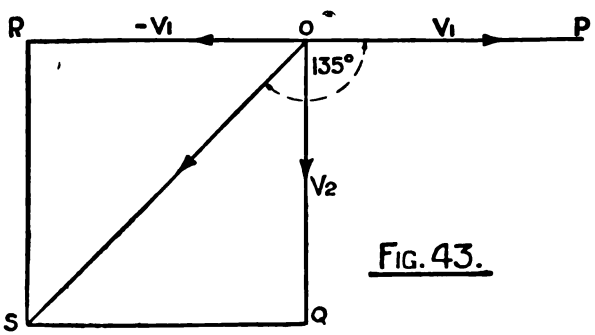

FIG. 43.

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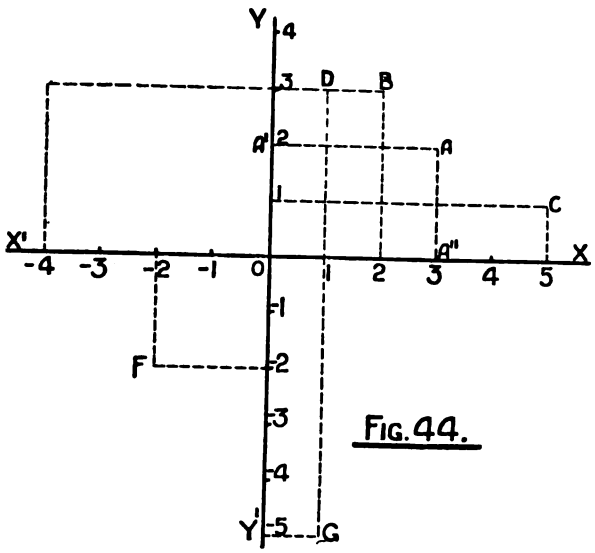

FIG. 44.

Squared Paper.

61. The great value of a piece of paper divided off into equal squares lies in the fact that it enables us, first, to completely *specify the position* of a point on its surface, and, secondly, to arrange that the position of such points may represent *conditions* of things or *facts*. This latter point will become more evident a little later.

In Fig. 44 we have a piece of squared paper, divided into four approximately equal parts, as shown by the lines XX^1 and YY^1 at right angles to one another and crossing at O. Let us number them along OX and OY—1, 2, 3, 4, etc., and along OX^1 and OY^1— -1, -2, -3, -4, etc., as shown.

If now we count, say, three divisions along OX from O and then count two divisions up, we arrive at the point A, which is three divisions to the right of YY^1 and two divisions above XX^1. This point A would be written as (3, 2).

This is the process of *plotting* the point (3, 2).

It is important to remember that the *horizontal measurement always precedes the vertical*, and bearing this in mind we see that the expression (3, 2) is sufficient to completely specify the position of the point A. In the same way the point (2, 3) is two divisions along OX and three divisions up, giving us B; C is the point (5, 1) and D is (1, 3).

62. The line XX^1 is known as the "axis of x," or the "x—axis," and the distances measured along or parallel to it are known as the "*abcissæ*" of the various points: the line YY^1 is called the "y—axis," and distances along or parallel to it are known as the "ordinates" of the points.

Thus, $AA' = A''O = 3$ is the abcissa of A (3, 2), and $AA'' = A'O = 2$ is the ordinate of A.

The abcissa and ordinate are classed together as the *co-ordinates* of A.

63. These points A, B, C, and D, are all in the *first quadrant*, and it will be noticed that only points in this quadrant

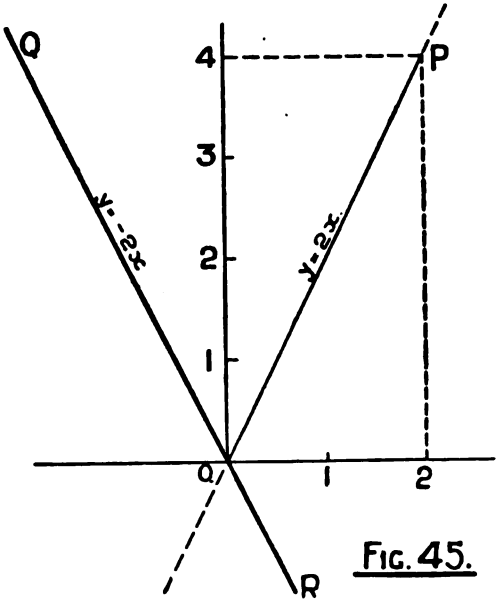

FIG. 45.

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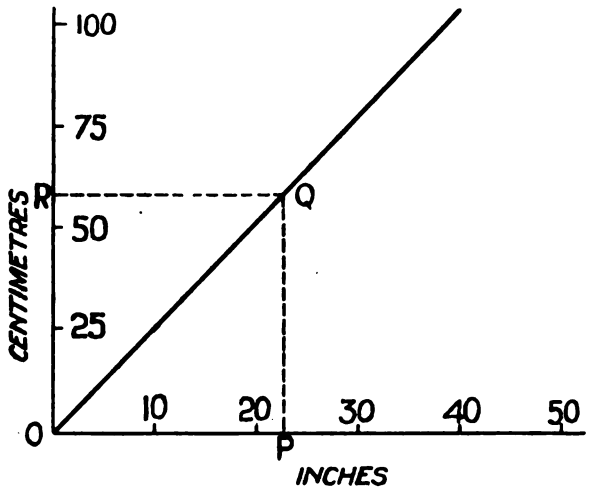

FIG. 46.

have *both* their co-ordinates positive. The points *E*, *F*, and *G* in the second, third and fourth quadrants respectively, are the points (−4, 3), (−2, −2), and (1, −5) respectively.

In Fig. 45 is shown the first quadrant only, and a straight line is drawn from the "*origin*" *O* (*o*, *o*) to the point *P* (2, 4). Now considering the point *P*, we see that the ordinate (4) is equal to twice the abcissa (2). Similarly at the origin *O* it is also true that the ordinate (*O*) is equal to twice the abcissa (*o*). Now we see that the straight line passes through the points ($\frac{1}{2}$, 1), (1, 2), ($1\frac{1}{2}$, $2\frac{1}{2}$), ($1\frac{1}{2}$, 3), among others. At each of these points the ordinate is equal to twice the abcissa, or the *y*-value is equal to twice the *x*-value. We are, therefore, justified in saying that for all points on the line *OP*, $y=2x$, or *OP* is a curve connecting *x* and *y* for the equation $y=2x$, or *OP is the curve of* $y=2x$.

64. This statement requires some amplification. We have taken only two points *O* and *P* as the two limits of our "curve," but it will be seen that by producing *OP* in the same straight line in both directions that all points on the produced parts also comply with the condition that *y* shall equal twice *x*. Thus *OP* is *part* of the curve $y=2x$.

It may seem somewhat foolish to call *OP*, which is a straight line, a "curve"; this, however, is simply because it is convenient to have a common term which can be applied to all lines showing, in this way, the relation between various pairs of quantities. It will be seen later that the relations are not always shown by straight lines.

The straight line, *QR*, is the curve of $y=-2x$.

65. As a simple example of a use for straight line curves let us take the curve of Fig. 46. This is drawn between (0, 0) and (40, 101·6). At the latter point the ratio $\frac{y}{x}=\frac{101\cdot6}{40}=2\cdot54$. Thus, all along the curve, $y=2\cdot54x$. That is, if we take any length *OP* along the *x*-axis from *O*, run up vertically from *P* to reach the curve at *Q*, and then along horizontally to reach the *y*-axis at *R*, then $OR=2\cdot54\times OP$. Now 1 inch = 2·54 cms, and so if *OP* to

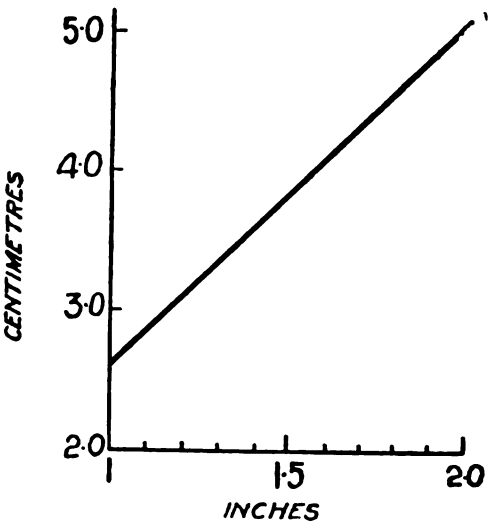

FIG 47.

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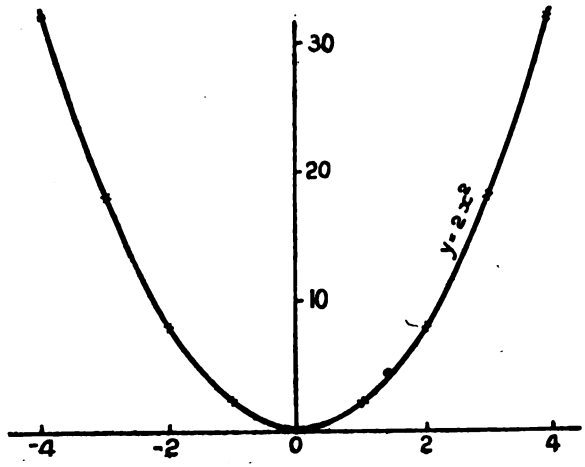

FIG. 48.

scale represents a certain length in inches, then OQ will represent, to its scale, the same length in centimetres. Thus we can, with the help of this curve, convert any length within the range of the curve from inches to centimetres or vice versa.

66. In this connection it is important to notice that it is only necessary to have scales, each of which covers the ground from 0 to 1, as we only want it to give us the *significant figures*. The position of the decimal point can be filled in independently of the curve. Thus one point on the curve would show us that

25 ins. = 63·5 cms.
·00025 ins. = ·000635 cms.
2,500,000 ins. = 6,350,000 cms, and so on.

Again, if we wanted to read off various corresponding values of inches and centimetres between 1 inch and 2 inches only, it would obviously be absurd to plot the values from 0 to 10 ins., and 0 to 25·4 cms, as the readings we wanted between 1 in. and 2 ins. would be so close together that large percentage errors would result. We should get much better results if we were to plot the particular small portion we want to a *larger scale*, as shown in Fig. 47. Now 1 in. = 2·54 cms, and 2 ins. = 5·08 cms, and so we draw a straight line from (1,2·54) to (2,5·08). From this curve we can read off any values we require between the limits 1 to 2 ins. and 2·54 to 5·08 cms.

67. In Fig. 45 we plotted the curve for the very simple equation $y=2x$. Let us now plot the curve for the less simple equation $y=2x^2$. The first step is to tabulate a few values as follows:

When $x=1$, then $x^2=1$ and $2x^2=y=2$
$x=2$, then $x^2=4$ and $2x^2=y=8$.

Continuing—

If $x=$	1	2	3	4	0	−1	−2	−3	−4
Then $y=$	2	8	18	32	0	2	8	18	32

The points must now be plotted and a fair curve drawn through them. In this case, Fig. 48, we obviously get quite a different curve from the straight line of Fig. 45.

There are several important

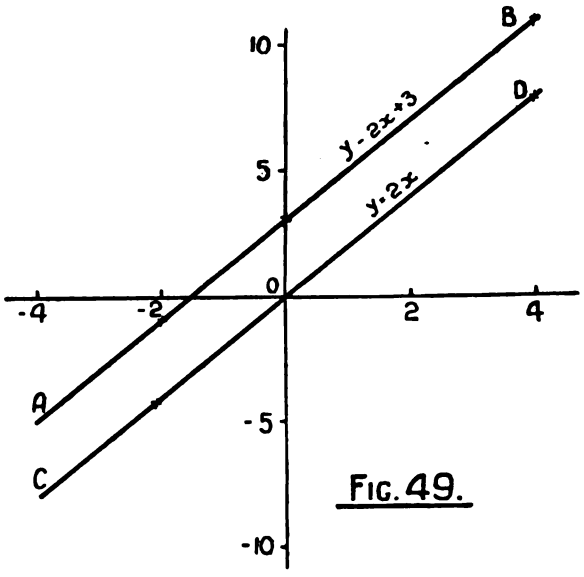

FIG. 49.

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things about this curve. The first is that it is symmetrical about the y-axis. The second is that as the curve only just *touches* the x-axis at the origin and does not *cross* to below it, there are no negative values of y. This is obvious, for y is the *square* of something, and the square of either a positive or a negative quantity is *always positive*. Thirdly, the *slope* of the curve is everywhere changing, and the farther from the origin we go the steeper the slope. This can be expressed by saying that the greater x becomes the steeper the slope of the curve, or the greater x becomes the faster does y increase. This is a general way of expressing the fact; in exact terms it can be shown by more advanced mathematics that the *rate of increase of* y is equal to four times x.

Thus when	$x=0$	1	2	3	4	5
the rate of increase of y is	0	4	8	12	16	20 and so on.

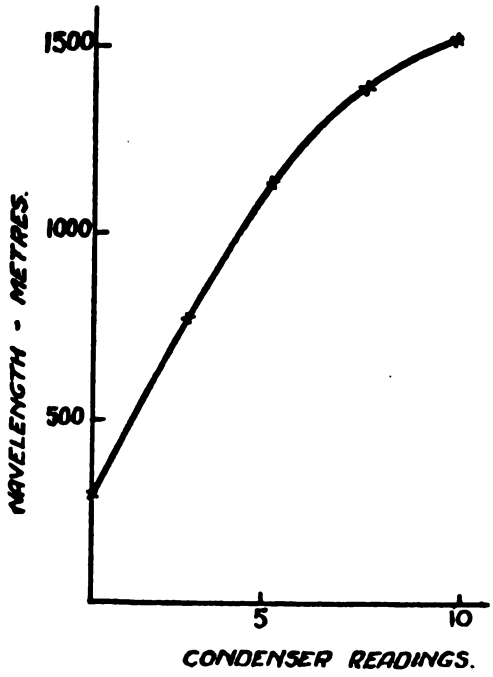

FIG. 50.

68. As a general statement we can say that when we have an equation which does not include any powers of x and y other than the first, the curve connecting the values of x and y will be a straight line. The curves for equations containing x^2, x^3, $x^{\frac{1}{2}}$, etc. will not be straight lines. For example, the curves of

$x=y$.
$y=3x$.
$17x=5y$.
$x=\frac{9y}{7}$ will be straight lines, while the curves of $x=y^3$.
$y=3x^5$.
$17x^{\frac{1}{2}}=5y^3$.
$x=\frac{9y^7}{7}$ will not be straight lines.

69 A slightly different type of equation to $y=2x$ is one such as $x=2y+3$, the difference consisting in the added constant $+3$.

Making out a table of values of x and y we get

$x=0$	2	4	-2	-4	
$y=3$	7	11	-1	-5	, and so on.

Plotting these values we get the curve AB (Fig. 49). For the purpose of comparison let us plot on the same sheet the curve $y=2x$—curve CD. We see at a glance that the curves are exactly similar, and that the curve, $y=2x+3$, is the curve $y=2x$ *shifted up* bodily through three divisions as a result of the $+3$ term which has been added. We shall consider this point in more detail in a later article.

70. In all the examples we have so far dealt with we have had equations such as $y=2x$, but it must not be imagined that x and y are the only two quantities which

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can be dealt with in this manner. We can plot any two quantities which are in some way inter-dependent, provided we know a sufficient number of pairs of values.

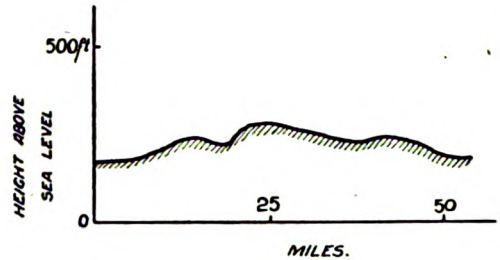

FIG. 51.

As a very common example, in wireless telegraphy we can draw a *calibration curve* of a circuit containing a fixed inductance and a variable condenser. The necessary pairs of values are, of course, simultaneous values of the scale reading of the condenser and the observed wave-length of the circuit. Suppose we have the following values :

Condenser at	..	0	2·5	5	7·5	10
Wave-length	=	300	770	1,140	1,390	1,510 metres.

Fig. 50 shows the curve obtained by plotting these values.

Again, by plotting distance along a road against height above sea level we get the *contour map* of Fig. 51.

71. For some special purposes we use squared paper, which is divided up not equally, but in a logarithmic ratio ; that is, divided just like the scales on a slide rule. This kind of paper gives straight lines for the curves of such equations as $y = 2x^2$, and so simplifies dealing with them.

[*Photo Central News*

SURVIVORS FROM S.S. "TARA," RESCUED FROM THE SENUSSI BY THE DUKE OF WESTMINSTER'S ARMOURED CAR FORCE. THE UPPER FIGURE ON THE LEFT HAND SIDE IS G. W. BIRKBY, WIRELESS OPERATOR

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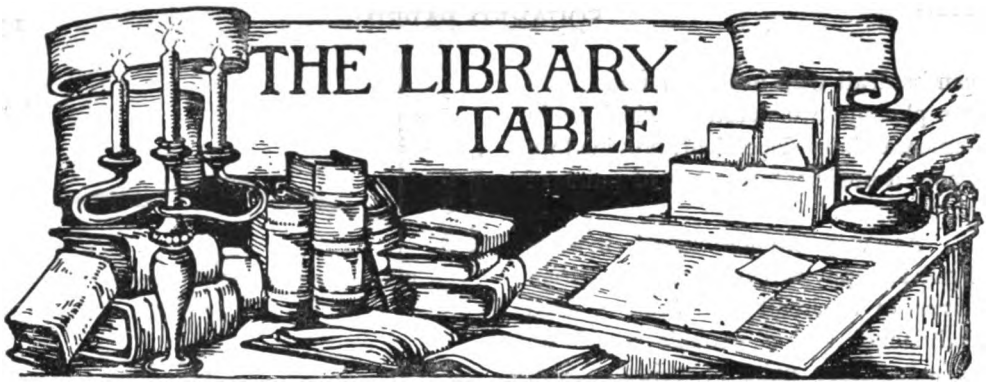

"AIRCRAFT IN WARFARE." By F. W. Lanchester, M.I.C.E., M.Inst.A.E. London: Constable & Co., Ltd. 12s. 6d. net.

It is impossible now for even the most sceptical to blind themselves to the utility of aircraft in warfare. The present unhappy campaign has, and is, amply demonstrating this fact. Various countries may possess different ideas. For example, Germany has pinned the greater part of her faith on airships (*i.e.*, of the gas-bag type). The Allies, on the other hand, whilst using "lighter than air" machines to a certain extent, have utilised to a very large degree the "heavier than air" machine.

The sub-title to Mr. Lanchester's book is "The Dawn of the Fourth Arm." He attempts to show, and there is a greal deal of truth in what he says, that, in the near future, air operations will occupy as important a position in warfare as do those on land and sea at the present time. The author deals with every phase of the subject, and discusses it from every point of view. His chapters include: comparisons between aeroplanes and airships, the technical aspect of aeronautics, matters dealing with gun-fire, and bomb and grenade dropping, rockets and air-borne torpedoes.

The book forms a worthy, if controversial, contribution to the literature on Aeronautics.

* * * * * *

"SUBMARINES." By F. A. Talbot. London: William Heinemann. 3s. 6d. net.

The late Sir Robert Ball set the fashion of writing readable books on technical subjects for the benefit of the general public. This sort of volume has found favour with the busy man of affairs for the acquisition of that insight into technical subjects which affords him an intelligent enjoyment of his newspaper. Mr. Talbot's book belongs to this class, and succeeds in arousing interest. Its readability enables us to record a few minor and incidental faults as perhaps inevitable. Its most serious defect consists in a somewhat loose use of the English language, resulting at times in that absence of lucidity which certainly should be avoidable by the adoption of the popular style. Thus, on page 32 we are informed that the Lake type differs from its rival in having the superstructure throughout the entire length of the boat. Then the writer goes on to say that "the main advantage of the superstructure, as advanced by its adherents, is that it makes the vessel more seaworthy," etc. Seeing that both kinds have a superstructure, this paragraph is distinctly confusing to the untechnical reader. There are times when a little more technical explanation would add to, instead of detract from, lucidity. Such is the case, for instance, when the author on page 49 refers to "reserve buoyancy" and leaves his reader to puzzle out exactly what he means. On page 91, the periscope is said to be a means of riveting the "observer's attention

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upon what is *transpiring*" (the italics are ours), a statement which would rouse the ire of the English purist, while the inclination to verbosity is exemplified in such expressions as "dynamic flight." What sort of thing, by the way, is "static flight"? The writer is over-fond, too, of the word "factor," and sometimes employs it when a more direct designation is possible. But it must be confessed that these faults are not numerous or prominent, and would for the most part be ignored in the interest of the reading. A reference to the use of wireless on submarines is made, but the subject, unfortunately, receives no detailed treatment.

* * * * * *

"THE BOY ELECTRICIAN." By Alfred P. Morgan. London: Duckworth & Co. 5s. net.

Among the many books for boys which have passed through our hands, this one will make a particular appeal to all who love to experiment and dabble in electricity. It is at once evident, upon opening the volume, that it is written by an American for Americans, but nevertheless it should be welcomed just as heartily on this side of the Atlantic as in the United States. The author explains on almost every page how some piece of apparatus can be made, and we cannot but admire the ingenuity with which many of the simple instruments are designed.

Commencing with the chapter on Magnets and Magnetism, we next proceed to a consideration of static electricity, and thence to static electric machines, cells and batteries, electro magnetism, measuring instruments, telegraphs, and practically every other application of the electric current. Numerous illustrations, both photographic and line, elucidate the text, and in many cases obviate lengthy explanations. Wireless Telegraphy is not forgotten, Chapter XIV. being exclusively devoted to this subject.

Space will not permit us to deal critically with the whole of this volume, and we will therefore confine ourselves to a few remarks on the "wireless" portion. We should not be doing our duty to future wireless experimenters if we failed to draw particular attention to the statement on page 47 as follows:—

"A good ground is absolutely necessary for the proper working of the apparatus. Amateur experimenters usually use the water or *gas pipes* for a ground. . . ." (the italics are ours). The highly dangerous practice of connecting the earth lead to a gas-pipe cannot be too strongly condemned. We are afraid that if the new experimenter attempts to connect his lead to such an earth, he will probably be the victim of an explosion which will effectively put an end to any further experimenting. We have many times pointed out in our pages how dangerous is this practice.

On the plate facing page 270 a bad error is made in entitling what is obviously an oscillation transformer as "an oscillation condenser"; and we are afraid that the relay described on pages 276 and 277 would scarcely be sensitive enough to work with the coherer indicated. In any case no mention is made of the size of wire to be used. Perhaps the author had some doubts himself on the subject, for, on the following page, he remarks concerning the outfit: "It will require some very nice adjustment before you can get it working properly."

The chief fault we have to find with this chapter, which is obviously designed to teach boys the principles of Wireless Telegraphy, as well as the construction of apparatus, is that the author makes no mention whatever of the name of Marconi. Considering that the whole of the gigantic fabric of wireless telegraphy has been built up upon the foundation laid by this great inventor, the omission is quite inexcusable.

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Altogether this is a highly interesting and practical book for boys, containing a liberal education in elementary practical electricity.

In view of the fact that both the construction and manipulation of wireless apparatus are at present prohibited in this country, we think that the Publishers would do well to attach a small slip to all copies sold in the United Kingdom, warning readers that any attempt to carry out the experiments in Chapter XIV. will render them liable to prosecution under the Defence of the Realm Act.

* * * * * *

"THE MATHEMATICAL ANALYSIS OF ELECTRICAL AND OPTICAL WAVE-MOTION." By H. Bateman, M.A., Ph.D. Cambridge: At the University Press, 1915. 7s. 6d. net.

Considerable attention is now being devoted in the scientific world to the study of the theory and propagation of electrical wave-motion, and, as a result, our knowledge of the underlying principles of wireless telegraphy is growing apace. The book under review, although highly mathematical in its treatment, will doubtless be welcomed by investigators who are endeavouring to solve the many problems with which we are daily confronted. In the preface the author explains that the book is intended as an introduction to some recent developments of the Maxwell's Magnetic Theory which are directly connected with the solution of the partial differential equation of wave-motions.

* * * * * *

"ELEMENTARY THEORY OF ALTERNATE CURRENT WORKING." By Captain G. L. Hall, R.E. London: The Electrician Printing and Publishing Co., Ltd. 3s. 6d. net.

Within the last few years a large number of text-books have been published dealing with the elementary theory of alternating current, and endeavouring to make clear to the student those principles which it is so important he should understand. Captain Hall has produced a well-written and clearly illustrated book, which will serve as an excellent introduction to the study of the larger treatises. The treatment is not of an advanced mathematical nature, and should be readily comprehensible to the student who has received an elementary mathematical training.

* * * * * *

"EXPERIMENTAL PHYSICS. A TEXT-BOOK OF MECHANICS, HEAT, SOUND AND LIGHT." By Harold A. Wilson, M.A., D.Sc., F.R.S. Cambridge: At the University Press, 1915. 10s. net.

Intended as a text-book for use in connection with a course of experimental lectures on mechanics, properties of matter, heat, sound and light, this book requires in the reader no previous knowledge of physics, and therefore will be found useful for those who are about to commence such studies. For some reason or other physics is not studied by the home-student to anything like the extent that it should be, and we are convinced that many more would take it up if they knew of the interest attaching to it. The study of sound is most fascinating, and a knowledge of this branch of physics should be of considerable practical use to the Wireless Operator, who is occupied, of course, in transcribing sound signals from the telephone. Light-waves are closely related to the ether-waves transmitted and received by wireless stations, so that here again we find a reason for the study of physics by the practical wireless man. We can strongly recommend this book for study in the quiet hours off watch, when a desire is felt to probe more deeply into the mysteries of nature.

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Personal Notes

In our personal paragraphs in the February issue on page 765 we erroneously mentioned the name of Mr. G. M. Bosworth as a director of the Marconi Wireless Telegraph Company of America. This is not the case, the gentleman in question being a director of the Marconi Wireless Telegraph Company of Canada, Ltd.

* * * * * *

Lieutenant Duncan Sinclair, son of Mr. J. H. Sinclair, a master at Aske Boys' School, Hatcham, has been gazetted as Equipment Officer in the Royal Flying Corps. The Headmaster of the school, in congratulating Lieutenant Sinclair, stated that his success was largely due to the keen work which he had done in connection with the School Wireless Telegraphic Club and the Cadet Corps.

* * * * * *

Information has reached his friends in Wishaw that Second Air Mechanic Alexander Dalziel, Wireless Operator, Royal Flying Corps, has been awarded the D.C.M. Details are not to hand, but it is known that the decoration was won by strict attention to duty under shell fire. He underwent a course of wireless training in Glasgow, and, having obtained his certificate, joined the Army. He has been attached to the 108th Heavy Battery, Royal Garrison Artillery, in France, for over a year.

* * * * * *

The clerical employés of Amalgamated Wireless (Australasia), Ltd., of Sydney, N.S.W., in conjunction with the operating staff, recently presented Mr. Cliff Atkinson, traffic clerk, with a cabinet of cutlery, a dinner service, and an afternoon teaset, on the eve of his marriage.

* * * *

We are very pleased to learn that Temporary Second Lieutenant Alexander Rorke, of the 17th Divisional Signal Co., Royal Engineers, has been awarded the Military Cross "for conspicuous conduct during operations in repeatedly repairing telephone and telegraph wires under heavy shell fire, thereby keeping intact the lines of communication." We offer our sincere congratulations to Lieutenant Rorke, who, before the war, was in the Drawing Office of the Marconi Company.

LIEUT. ALEX. RORKE.

* * * *

We have pleasure in reproducing this month a portrait of Mr. G. E. Pohu, who recently proceeded to sea on his first trip as a wireless operator. Mr. Pohu joined Marconi's Wireless Telegraph Co., Ltd.,

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on July 1st, 1913, as a telegraph messenger, and soon showed himself to be a youth of more than usual smartness and ability. After nine months' service as a messenger he was appointed to more important work inside the office and quickly "made good" in his new position. During his spare time Pohu studied wireless telegraphy in the Marconi Company's Evening Classes, and upon obtaining his Postmaster-General's Certificate of Proficiency transferred to the Marconi International Marine Communication Co., Ltd., and received the appointment above mentioned to the operating staff. We congratulate Mr. Pohu on his advancement, and trust that he will continue to progress as rapidly as he has done heretofore.

OPERATOR G. E. POHU.

* * * * *

From the *Leeds Mercury* we learn that Arthur Barrett, A.B., Acting Wireless Operator, is home at Wetherby on leave, just recovered from a wound received off Cape Helles, Gallipoli, during the evacuation of the Peninsula. The vessel on which he was serving had her wireless damaged by a shell, and Barrett volunteered to ascend the rigging to effect the necessary repairs, it being impossible to despatch or receive messages. Before he completed the task he was shot through the left ankle by a sniper from the shore, but he pluckily finished his work before descending.

In the engagement in the North Sea when the *Blucher* met her end he was aboard the *Lion*, and on that occasion was wounded in the arm by a flying splinter of shell.

* * * * * *

We understand that the D.S.O. has been awarded to Lieutenant-Commander E. L. Colley Grattan, R.N., who was in charge of the wireless telegraphy at Cape Helles in Gallipoli from May 1st until the evacuation of the Peninsula. Admiral de Robeck reports that the work carried out by this officer has been of inestimable service. A similar distinction has been conferred on Commander J. F. Somerville, R.N., Fleet Wireless Officer, who performed duties of exceptional difficulty most efficiently. Acting Warrant Telegraphist John A. Britten, R.N., has been the recipient of the Distinguished Service Cross. He displayed great ability and resource in erecting a wireless station at Cape Helles under fire. We congratulate these very gallant gentlemen.

* * * * * *

We learn with regret that leading telegraphist Arthur Crane, R.N., of Catford, was washed overboard and drowned on February 24th. He was in the battle of Heligoland on August 28th, 1914, and later saw much arduous service in the North Sea.

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Company Notes

MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA

The operations of this Company for the past fiscal year show, before allowing for reserves, a net income of $288,994.68, as compared with $271,888.71 for the year 1914.

While progress has been hampered by the restriction of ocean travel, and the postponement of the Marconi transatlantic wireless service owing to the European war, nevertheless the Directors feel that substantial improvements have been made in the operation of the company's affairs, and that the past twelve months reflect the beneficial results of careful organisation of executive and administrative forces. The new policies of standardising wireless equipment and contracting for its use on a basis which provides a fair return for the service rendered are now well established with ship owners, and have found favour with newcomers into the mercantile marine field. Important economies in operation have been effected and have resulted in a substantial saving, as is later shown. Although the efforts of the officers during the past year have been largely directed to conservation and perfection of organisation on account of the indefinite suspension of transatlantic activities, the company has extended its service materially and greatly raised the standard of its mechanical and electrical equipment, thereby laying the foundation for further extension of operations with the return of normal conditions.

With wireless communication featured prominently in the official measures taken for the safeguarding of the country, it is reassuring to know that the company, representing practically the entire American field of commercial wireless telegraphy, is managed by Americans and conducts its operations under the direct supervision of the United States Government. Any suggestion that its control is in the hands of foreign interests through capital investment is directly refuted by a very recent analysis of its list of stockholders—numbering 23,027, of whom 21,664 are residents of the United States.

Notwithstanding that practically all passenger traffic to and from European countries has been suspended by reason of the war, and that American shipping has been withdrawn from the Pacific, it is gratifying to report that, due to excellent coastwise service, the receipts from message traffic during 1915 were only about 8 per cent. less than for 1914.

There are at present nearly 560 ships equipped with Marconi apparatus manufactured by the company, the majority of such equipments being leased at the company's new rental rates, in each case for a term of years. A considerable increase in the number of contracts has been made; and among the largest may be mentioned the equipment, early in the year, of thirty ships of the Standard Oil Company of New Jersey, and, at the close of the year, a contract for standard installations on thirty-six large power barges about to be operated on the Mississippi River by the Inland Navigation Company. The apparatus is now being installed on the first of these barges, and the remainder will be equipped as fast as they are placed in service. This large equipment of Marconi wireless apparatus on inland river barges (the largest of which approximates 5,000 tons) is the most interesting and promising development of the company's marine service during the year. The application of wireless on such a large scale to river navigation is being watched with keen interest by other large freight carriers, and in fact the entire shipping industry of the country. Since the beginning of the year 1916 thirty-five ships have been equipped with Marconi apparatus, and, with every American shipyard working to full capacity, the company expects to contract for many new installations during 1916. Particularly is this so in view of the now generally acknowledged truth among all progressive shipowners that no vessel in coastwise or ocean trade is completely equipped unless fitted with a Marconi wireless installation. The United States Government requires many steamships to carry wireless apparatus, but the increasing number of voluntarily equipped vessels indicates clearly the utility and economic value of Marconi equipments now regularly installed on small freight steamers, river barges, pleasure yachts, and tug boats.

In a tornado which blew continuously for eighteen hours in south-west Texas, beginning on August 16th, 1915, the company's station served as the only means of keeping the important city of Galveston in touch with the rest of the world. The storm spent the greater part of its fury on this gulf port, and, notwithstanding its sea-wall protection, water backed up from the bay and filled the streets to a depth of several feet, rendering power plants and the land telegraph and telephone services useless. When at last the mast of the Marconi shore station was blown down and the rising waters silenced the apparatus, the operators were transferred to a ship lying in port, from which communication was at once established with the company's station at Port Arthur. Messages were handled for steamship companies, the military authorities and the general public without interruption. In the midst of the widespread devastation, the mast and guy anchors of the company's station at Port Arthur also gave way, but here again communication was quickly re-established from a near-by steamship.

There has been no change in the commercial status of the transatlantic stations, the high-power equipments remaining closed to business on account of the war. The British Admiralty still holds for Imperial Government use the English plants constructed to operate with the company's Belmar and New Brunswick duplex stations, and, thus far, because of the war, it has been impossible to open similar direct service with Norway and Northern Europe, through the newly completed high-power stations at Marion, Mass., and Chatham, Mass.

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Reliable and rapid service has been maintained between the company's stations in California and Hawaii, and the volume of traffic shows steady improvement.

The Hawaiian stations are known as two-way stations, being constructed so as to work with California and Japan simultaneously. The Japanese Government recently notified the company that its new wireless stations at Funabashi and Otchisi, near Tokio, are complete and tests are now being made daily with a view to early inauguration of a public service, spanning 5,600 miles of the Pacific. Negotiations on traffic regulations are now in progress with the Japanese Government Department of Communications, and it is expected that by means of the Japanese Government cables the service will be extended to China, Manchuria, and other Far Eastern countries.

The new circuit connecting the United States with Alaska was opened in August, 1915, and has since furnished reliable communication throughout the 826 miles covered by the company's stations at Astoria, Ore., Ketchikan and Juneau, Alaska. Although operated in competition with the submarine cable, the wireless traffic has shown steady increase each month, and has given practically continuous service, whereas the cable is operated but six hours daily. Many times since the opening the cable service has been interrupted, and the company's system has furnished the only means of communication with the territory. A reduction of some 20 to 25 per cent. in rates, and the establishment of three classes of dependable service, have been the means of making the Marconi service exceedingly popular, and it has been highly commended by the Alaskan Press, commercial houses and the public.

Satisfactory progress has been recorded in the development of a commercial wireless telephone. The year brought about several interesting developments in the art of wireless telephone communication, and pending the decision of the research engineers as to the relative merits of these developments the Directors have thought it advisable to delay the commercial introduction of the wireless telephone.

The engineers have given special attention to the design of suitable wireless equipment for aeroplanes and are confident that highly efficient apparatus for communication from aircraft will soon be developed. The United States Government, and also foreign Governments, have expressed the keenest interest in such apparatus.

The injunction order issued by the U.S. District Court, restraining the DeForest Radio Telegraph and Telephone Company from infringing fundamental Marconi and Lodge patents, was affirmed by the Circuit Court of Appeals on May 13th, 1915.

The trial of the suit begun October 24th, 1914, against the DeForest Company, based upon infringement of the Fleming vacuum valve patent, is actively progressing.

The injunction issued in the suit by the company against the Atlantic Communication Company (the Telefunken system of Germany) has been modified with the consent of the Directors to permit an increase of power in the Sayville station, and a bond filed to protect the interest of the company.

On August 14th, 1915, suit for infringement of the Marconi and Lodge tuning patents was begun against Kilbourne and Clarke, of Seattle, and is now being vigorously prosecuted at Seattle, Wash.

By instituting system, with a rigid scrutiny over all expenditures, and by using the most efficient methods, the management of the company has effected a substantial reduction in expenses, totalling $111,054.55 compared with the previous year.

The income derived from investment of surplus funds amounted to $87,010.01, and adding $17,922.96 interest on stock subscription, the total income from these sources for the year was $104,932.07, as against $150,274.21 for the previous year. The reduction is explained by the liquidation of investments necessitated by capital expenditures. The reserves set aside out of the 1915 profits for the depreciation account have been determined on practically the same basis as in 1914. After setting aside all reserves, the net profits for the year amounted to $177,316.51, or an increase of 18.30 per cent. over the profits for the previous year. This amount has been added to the surplus, increasing that account to $541,887.52 at December 31st, 1915, and the Reserve set aside at that date against depreciation amounts to $373,415.34.

AMALGAMATED WIRELESS (AUSTRALASIA), LTD.

THE fifth half-yearly ordinary general meeting of the Company was held at the registered office, Wireless House, 97 Clarence Street, Sydney, on February 29th last. The directors' report for the six months ended December 31st, 1915, states that trading for the period has still been seriously interfered with by the war, and profits from this source are naturally reduced.

The ship's message traffic, specially referred to in the last report of the directors, shows an increase as compared with the last report, but remains adversely affected by censorship and naval restrictions.

The number of ships now operated by the Company remains as before; additional ships have been fitted but only counterbalance those withdrawn from the Company's operation by sale or otherwise.

The manufacturing Department continues to meet all local and mercantile demands and also the urgent requirements of the naval authorities.

The Training School continues to do admirable work, and has supplied many important calls upon it for skilled operators in both civil and official service.

Mr. John M. Jolly, one of the directors, owing to his continued absence from Australia, has resigned. It is not proposed for the present to elect a director in his place.

The net profit for the period under review amounts to £2,229 17s. 6d., which, with £1,101 14s. 7d. brought foward from the previous half-year, leaves a balance to the credit of profit and loss account of £3,331 12s. 1d., which the directors propose to carry forward to next account.

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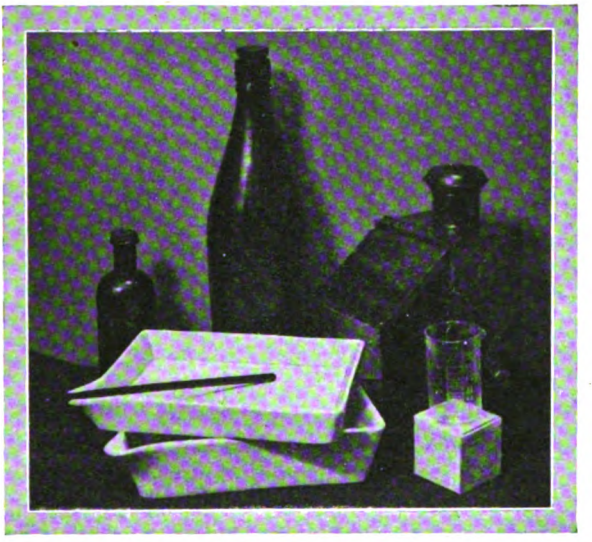
Pastimes for Operators

II.—PHOTOGRAPHY

By PERCY W. HARRIS

With Illustrations by the Author.

PERHAPS no hobby amongst wireless men has more devotees than photography. It may well be called the King of Hobbies for both sea-going and shore-station operators, as not only does it give pleasure to the person practising it, but it also enables his companions, relations, and friends to share in his enjoyment. Many are the homes which look forward with eager anticipation to the next batch of prints from their "boy at sea" or in foreign climes; for the finest piece of descriptive writing cannot equal a photograph, however imperfect it may be technically, in its power of depicting strange places and interesting events.



A COMPLETE DEVELOPING AND FIXING OUTFIT.

Although so many operators take their travels with them on some sort, few know how to practise the camera of best advantage. Photography unfortunately has the reputation of being "messy" and expensive, and in truth often it is so when carried out in an indifferent and unsystematic manner, but considerable experience has convinced the writer that it need possess neither of these faults if properly managed; and, indeed, at times it may even be rendered profitable.

THE QUESTION OF COST.

The matter of expense must be considered under first cost and "running expenses." The first cost covers the camera, and accessories, and the developing and printing outfit (for it is presumed that the photographer will carry out all of the processes himself—he is no true photographer if he doesn't !). The running expenses depend entirely on the size of the camera and the number of photographs taken and printed. The camera need be neither elaborate nor expensive; good work can be produced as easily with a thirty-shilling instrument as with an elaborate machine costing as many pounds, although the range may not be so wide as with the more expensive outfit. The quarter-plate size is as useful as any, and will give a picture of reasonable size without enlarge-

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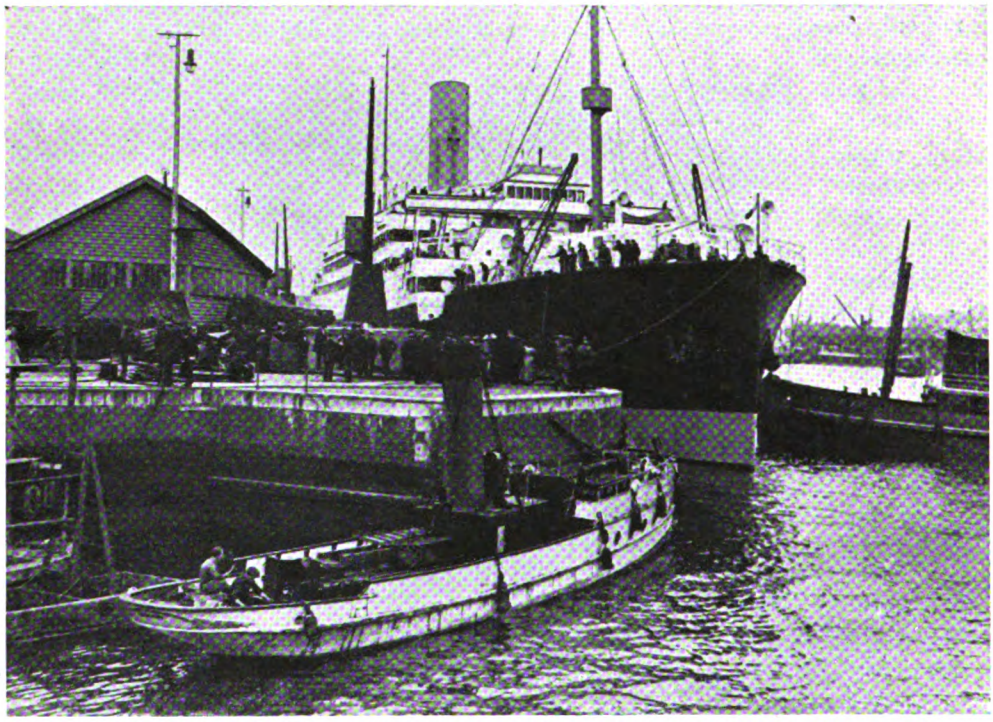
ment, although the " vest pocket " type of camera is deservedly popular, on account of its extreme portability. The folding pocket type should be chosen if possible and as good a lens as the purchaser can afford should be selected. An excellent instrument capable of turning out beautifully crisp and sharp negatives of quarter-plate size under all ordinary conditions can be purchased new from several makers for about £3 10s., and many a good serviceable camera of this quality can be bought second-hand through a reputable dealer for about two guineas. A " Vest Pocket " camera can be purchased for £1 10s. or less.



S.S. " ANDES " ON SAILING DAY. AN AMATEUR SNAPSHOT FROM AN UNCONVENTIONAL STANDPOINT IS USUALLY FAR MORE INTERESTING THAN THE CONVENTIONAL PICTURE POSTCARD.

A NOTE ON LENSES.

A word or two concerning the difference between various lenses may be useful here. Photographic lenses can be roughly divided into three classes : achromatics, rapid rectilinears (sometimes called " aplanats " on foreign cameras) and anastigmats. None of these give sharp pictures if improperly focused (a point to be borne in mind when blaming the camera for a poor picture !), but all will give good results if properly handled. The " achromatic " type is the cheapest, and is that fitted to the cheap snap-shot cameras of the " Brownie " class. It works with a fairly small stop (f/11 and under), and gives good results in bright light such as one usually gets at sea, but the definition falls off slightly at the corners of the picture, and there is a tendency to distort straight lines falling near the edges. The rapid rectilinear or symmetrical lens is of a higher grade, working at a larger aperture (usually f/8) and possessing

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greater defining power and absence of the distortion mentioned above. The anastigmat is the finest of the three, giving "pin-sharp" pictures to the very edge and enabling good pictures to be taken in poor light or with very short exposures. Pictures taken with anastigmat lenses may often be enlarged to an enormous size without becoming "fuzzy." The photograph of a jumping horse shown on page 160 was taken with a high-grade anastigmat at one-thousandth of a second on a plate 3½ in. by 4¾ in. (9 cm. by 12 cm.), and has been enlarged up to 3 ft. in length without showing appreciable falling off in definition. Such lenses are expensive and require care in focusing to get the best results.

Besides the camera, it is very useful to have a stand or tripod for work ashore when snap-shots cannot be taken. Very handy and portable telescopic tripods are obtainable in metal, and if carefully used will stand any reasonable amount of wear and tear. Good work in bad light may often be done by resting the camera on some convenient support, and the author has on more than one occasion photographed the interiors of mosques in the Near East without a stand by pressing the camera against a pillar to steady it. Some form of exposure meter is a *desideratum*, as the lighting at sea and abroad is most deceptive. This point will be considered further on in the article.

A Simple Developing Outfit.

The developing and printing outfit need not be at all expensive or elaborate, for work in the dark-room has been greatly simplified during the last few years. The photograph on page 157 shows all that is needed in the way of bottles, dishes, etc. In addition a printing frame will be required. The large bottle at the back can easily be obtained from the steward, and is used to contain the fixing solution. The smaller bottle is that holding the concentrated developer, of which there are a number of excellent makes now obtainable (Azol, Victol, Rodinal, Certinal, Kodol, etc.). A 3 oz. bottle of any of these costs about 1s. 3d., and will make at least 72 oz. of developer for plates and films, or slightly less for gaslight papers. The small dark-room lamp, burning oil, costs 1s. 9d., and has served faithfully for several years, often under trying conditions. The dishes shown are of porcelain, which has the advantage of being readily cleaned, but xylonite trays are preferred by many for their lightness and unbreakability. Underneath the

"STROMBOLI, EVENING." DELIGHTFUL EFFECTS SUCH AS THESE ARE EASILY OBTAINABLE EVEN WITH THE CHEAPEST CAMERAS.

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EXPOSURE 1/1000TH OF A SECOND. AN EXAMPLE OF HIGH-SPEED WORK WHICH CAN ONLY BE UNDERTAKEN WITH THE FASTEST OF LENSES, SHUTTERS AND PLATES. IT IS A PURE WASTE OF TIME TO ATTEMPT THIS KIND OF WORK WITH AN ORDINARY CAMERA.

measure is a small box of hypo eliminator. A celluloid stirring rod for keeping prints under the solutions completes the outfit.

PLATES OR FILMS?

A question asked by practically every beginner is "Which shall I use, plates or films?" Both have their advantages. Films are preferred by many camera users for their lightness, daylight loading, the facility with which they can be changed, and the fact that they can be developed without a dark-room. Half a dozen rolls of film, each containing enough for twelve exposures, may be carried about without inconvenience in the pockets of a coat, whereas six dozen plates, even of small size, form a burden not lightly to be taken up. The disadvantages of films are that they are more expensive than plates (but not much more with plates at their present war price); they do not permit of the use of a focusing screen on ordinary cameras; they are inconvenient to develop, except in special and expensive tanks; and, last but not least, it is necessary to wait until the whole spool has been exposed before any particular film can be developed. This is a fruitful cause of wastage, for many enthusiasts "run off" the remaining two or three exposures of the reel on subjects they do not particularly wish to snap, just for the sake of being able to develop some special photograph in which they are interested.

Plates are rather weighty, but they are far easier to handle in developing than films, and can be procured in many speeds and qualities to suit particular work. Films are only obtainable in one speed, which is not so fast as that of many plates, with the result that the highest speed work is invariably done on the latter. It is true that plates require to be loaded into the dark slides and developed in a dark-room, but if the photographer makes a practice of seeing that his slides are full each night and of developing after dark he is not likely to be much inconvenienced in this respect.

Although the writer commenced his photographic work at sea with films, he soon abandoned them for plates, and never regretted the change. The ability to use a camera focusing the picture on the ground glass screen is an advantage not to be

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overlooked, and the convenience of being able to develop a single plate when required will be much appreciated. Unless the operator wishes to photograph very extensively, he will not require to take a large stock of plates to sea, and the weight of a good supply for the whole voyage should not exceed that of a couple of pairs of boots. Before leaving the subject it may be mentioned that films are usually more liable to scratches and pin-holes than plates, due to the fact that the sensitive material has to be drawn through the back of the camera from one spool to another.

Exposure.

In a short article such as this detailed consideration cannot be given to points such as exposure, and the reader is advised to purchase the Watkins Manual, costing a shilling. In this book exposure and development have been brought down to an exact science, easily understandable by all and productive of the finest results, if only a few simple rules are followed.

The wise photographer at sea will not guess his exposures, but calculate them with some form of exposure meter or calculator. Of these the Bee Meter is as good as any, costing 3s. 6d. The Burroughs-Wellcome Calculator, at 1s., is also excellent. Conditions of light at sea are very deceptive even to the expert, and, furthermore, they differ with every latitude. The cost of an exposure meter will be saved in one voyage in plates or films which would otherwise have been wasted, so that its purchase is to be recommended from motives of economy alone.

Development and Fixing.

If no dark-room is provided on board, the operator will have to do his developing at night, unless, of course, he uses a daylight developing film tank. The highly concentrated developers mentioned in a previous paragraph are particularly recommended for use at sea, as they occupy little space, are clean and non-staining in working, and may, furthermore, be used equally well for gaslight papers. A dilution of one part of concentrated developer to thirty of water is a good working solution, in which a plate will develop in six or seven minutes. Stronger solutions give quicker development. The many tablet and powder developers now sold are also very convenient. After development is completed the plate need not be washed, but can be placed straight in the fixing bath, provided this latter is made with acid fixing salt. The dish should be rocked for a few seconds immediately the plate is immersed in the fixing solution, and then left until the creamy colour is gone, and half as long again. This point is important, for a plate is not fully fixed immediately the creamy appearance is removed, and if taken out at once may develop yellow stains after a month or two.

Washing.

The proper washing of plates and films is one of the chief difficulties which present themselves to the seagoing operator. A supply of running water is, of course, out of the question, except in port, and as a consequence many negatives have been ruined. Fortunately, however, hypo eliminators are now obtainable, and by their use all traces of fixing salt can be removed with a minimum of water, a couple of dozen negatives and prints being completely washed with a single filling of the water tank in the cabin "clock" or washstand.

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"A HOUSE IN POMPEII." MANY OPERATORS VISIT NAPLES IN THE COURSE OF THEIR VOYAGES. POMPEII IS EASILY REACHED BY THE ELECTRIC RAILWAY AND SHOULD NOT BE MISSED BY THE PHOTOGRAPHER.

The small box under the graduated measure in the first illustration contains enough hypo eliminator to remove the hypo from a thousand or two negatives or prints, and costs 9d. The substance may be used as follows :—

Dissolve a pellet of the hypo eliminator in water according to the instructions, and pour the solution (which can be used many times over) into a dish. Give the negative or print a brief rinse in a little water after removing it from the fixing bath and then place in the eliminator for three minutes, the dish being rocked continually. At the expiration of this time remove the negative and soak it in three changes of water (two or three minutes for each change). A couple of ounces of water for each quarter-plate is quite enough, and the negative or print is then set up to dry. Plates and prints treated with this eliminator by the author three years ago are just as good now as on the day they were made, and will probably be so in thirty years' time. If running water is available, washing for three minutes after the removal from the eliminator is quite sufficient.

If a fan be provided in the cabin, this will be found very useful for drying, twenty minutes in front of a fan usually sufficing to dry a negative, and much less time for a print.

MAKING THE PRINTS.

For printing there are many different kinds of paper, but the two most popular at sea are "self-toning" and "gaslight." The first prints out in daylight and has the

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advantage that the progress of printing can be judged by inspection from time to time; the second, as its name implies, prints by artificial light. Self-toning papers give prints varying in colour from a warm brown to a purplish brown, depending on the make of paper and the treatment given. Gaslight papers give black and white prints, which have to be developed and fixed. Their chief advantages are speed and the fact that no daylight is required for their manipulation. With an ordinary electric light, as fixed in the cabin, negatives can be printed very rapidly, thin negatives requiring only a few seconds. Development occupies but a minute or two and fixing about ten minutes, washing being carried out as described under the last heading. A point to be remembered when selecting a printing process is that, whilst self-toning papers give excellent prints from *good* negatives, nothing beats gaslight paper for obtaining the best result from a poor negative.

A Few General Hints.

Operators taking cameras to sea in these times should make themselves fully acquainted with the restrictions imposed by the authorities upon photographing, so as to avoid contravening the Defence of the Realm Regulations.

Stick to one make of plate or film, paper and developer, until you have thoroughly mastered the technique. Developers in particular vary enormously in their properties, and you may be misled as to whether or not a plate is fully developed with a strange solution. When you have a developer and materials which give satisfactory results don't experiment with others unless you can afford to waste a good many photographs.

Keep the direct rays of the sun out of the lens, or you will get foggy negatives.

Ninety per cent. of photographic failures come from under-exposure. "If in doubt, double the exposure," is a safe rule to follow.

Paste your prints in an album if you wish to keep your collection intact. Make duplicate prints for friends. Slip-in albums are a snare and a delusion. They should properly be called "Slip-out" albums.

Don't be misled by colour effects. Remember that a photograph comes out in monochrome. This is why most sunset photographs are so disappointing.

When choosing a camera, do not attach too much importance to high speeds on the shutter; they are rarely accurate. A shutter with $\frac{1}{5}$th, $\frac{1}{10}$th, $\frac{1}{25}$th, and $\frac{1}{100}$th sec. will be far more useful for general work than one with $\frac{1}{25}$th, $\frac{1}{100}$th and $\frac{1}{250}$th.

The speed of $\frac{1}{5}$th sec. is very useful for portraiture in diffused light or in the shade of a deck house.

Never take portraits in the full sunlight; the results are rarely flattering and may get you disliked by both sexes.

A Word in Conclusion.

This article is written mainly for those who have had a little experience with a camera and need guidance. If you desire to study the subject from the beginning you can obtain from any of the large camera makers (Kodak, Houghtons, Butchers, etc.) a free booklet explaining the basic principles of the art and telling you just what to do when starting. Finally, the Editor of The Wireless World will be pleased to answer readers' queries and give advice on photographic subjects to all who require it, in the "Questions and Answers" column of this magazine.

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"Follow the Crowd"

A Jolly Revue at the "Empire"

THE "Empire," Leicester Square, is known the world over as *the* house for revues. They always seem to get hold of the right people, and manage somehow or other to stick to them. Such favourites as Miss Ethel Levey, Miss Fay Compton, Mr. Robert Hale, and Mr. Joseph Coyne always draw large audiences. The house was packed when we were privileged to witness the performance. The whole thing was perfectly staged, and the dresses, particularly in the "Vogue" scene, were superb. There are some taking bits of music in it too, but, what will particularly attract our readers, a whole scene is devoted to wireless telegraphy. The Marconi cabin on the s.s. *Empire* is portrayed, while a very portentous radio set graces a table inside the cabin. By the courtesy of the manager, we are enabled to reproduce herewith a picture of Mr. Robert Hale as the Marconi operator, discussing men and things with a deck hand, who is impersonated by Mr. Tom Walls. The whole course of this conversation is interrupted by wireless signals, and the operator has continually to break off in order to receive these wonderful messages which arrive from all parts of the world. His discussion on political affairs is most amusing, but this is capped by the receipt of a marconigram announcing the arrival in his own family of a trio of little Hales.

We cannot close this short *critique* without a reference to the excellence of the dancing, and the superbly pretty scenery which graces the first scene of Act 2—"At Honolulu."

Our advice to all our readers is not to "Follow the Crowd" but to lead them, in order that they may be sure of obtaining admission to the theatre.

[*Photo copyright by Empire Theatre, Leicester Square, W.C.*

THE MARCONI OPERATOR "DISCUSSING MEN AND THINGS WITH A DECK HAND."

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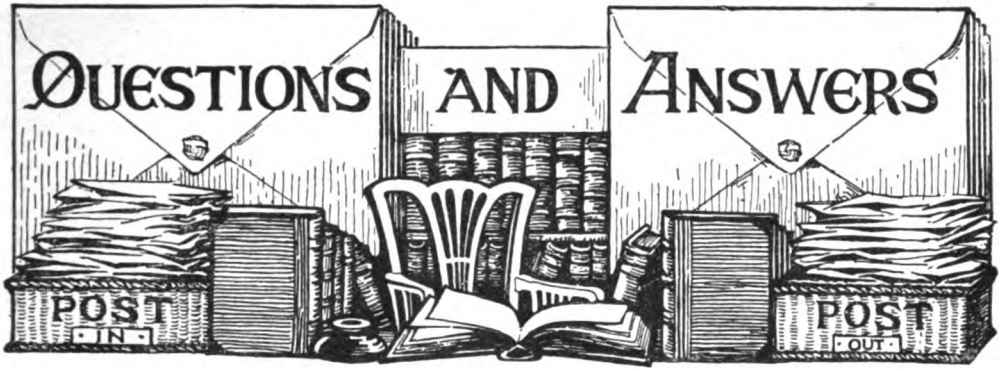

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.*

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

J. E. A. (Leeds).—We are unable to give you any information on the subject of the wireless equipment of aeroplanes.

We are also not in a position to supply advanced copies of articles in the forthcoming Year-Book.

For the purpose of joining the service you mention, you will probably find a general knowledge of practical wireless telegraphy of far more use to you than specialised information as to the particular sets at present in use.

J. H. D. (Edinburgh).—The first series of instructional articles have been reprinted as *The Elementary Theory of Wireless Telegraphy*, by Bangay Price, 1s. 2d., post free.

The second series are in preparation, and an announcement will appear in due course in THE WIRELESS WORLD.

The P.M.G.'s examination consists of a practical and an oral examination in theory. No papers are published, but you will find the series of Test Cards published by the Wireless Press, Ltd., price 1s. 2d., post free, to be useful in preparing for the examination.

O. K. C.—In calculating the wave-length of an aerial from its calculated or measured inductance and capacity, the formula

$$\lambda = 1885\sqrt{LC}$$

must not be used since it is only true for a circuit with localised inductance and capacity. For an aerial with no added inductance the formula is

$$\lambda = 1885\sqrt{LC} \times \frac{2}{\pi}$$

as shown in the article on the calculation of wave-lengths of aerials in the March number.

Even this formula is only true for an aerial with a uniform inductance and capacity per unit length. For an aerial of two parts with different values for these quantities per unit length (such as formed by a flat top aerial and its down lead) the formula becomes very complicated as explained in the footnote to the article referred to, which will answer the other queries in your letter.

J. H. (Highgate).—We advise you to read again the text-books on electricity and magnetism which you studied up to 1914, as the discovery you have made is fully explained in them in a much better way than can be done in the space at our disposal in these columns. When a current flows along a wire it creates a magnetic field round it. The lines of force produced form close circles round the wire.

If the wire is vertical a compass needle will point in the direction shown in the figure where

NS

S | O | N
N | W | S

SN

W is a section of the wire in which the current is flowing upwards.

For a horizontal wire you should take a short magnetised needle suspended by a thread, and you will then find that if the needle be above the wire it will deflect with the north pole to the right, and if underneath it will deflect to the left. If it is on the same level as the wire it will set vertically with the north pole down when on one side, and with it up when on the other side of the wire.

The figure will explain this also if it be regarded as a vertical section through the wire.

P. B. Vannes (France).—The book on *Theory of Electrical Oscillations*, by Mr. L. Cohen, has not yet been published, but an announcement will appear in this journal when it is on sale. Enquiries as to the vacancies for and prospects

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of constructional and installation engineers in the Marconi Companies should be addressed to the Head Office of the particular company it is wished to join.

S. S. T. (Gt. Yarmouth) enquires: (1) What is meant by the reciprocal of the capacity of a condenser.

(2) Referring to Hawkhead and Dowsett's "Handbook," page 152, he enquires what is meant by the angle of lag or lead for an alternating current circuit.

(3) On page 163 it states that a frequency of 30,000-20,000 will give an audible note, and enquires how a spark of 600 to 700 gives an audible note.

Answer.—(1) The reciprocal of any number is obtained by dividing unity (i.e., 1) by that number. Thus the reciprocal of 2 is $\frac{1}{2}$, of 9 is $\frac{1}{9}$ and so on.

The reciprocal of the capacity of a condenser is obtained in the same way. Thus a condenser with a capacity 02 microfarads has a reciprocal value of $\cdot 0\frac{1}{2}$ or 50, and this number may be used for calculations with respect to the condenser exactly as shown on page 88 of Hawkhead and Dowsett.

(2) When an alternating current flows in a circuit including an inductance or condenser or both then, in the general case, the current and the voltage at any part of the circuit *will not reach a maximum at the same instant* but one will reach its maximum at a short time after the other. Instead of reckoning the interval between these points in fractions of a second it is necessary to reckon it in angular degrees; the complete period of one alternation of the current (or voltage) wave being divided into 360 "electrical degrees" and the intervals between any points, such as the two maxima referred to, divided in proportion. This method is adopted for purposes of calculation.

(3) The statement on page 163 should read "a frequency of 30 periods to 20,000 periods per second will give an audible note. Hence since 600 to 700 come between these limits, an audible note is given by sparks of these frequencies."

J. J. M. (Co. Westmeath).—The *Handbook of Technical Instruction*, by J. C. Hawkhead and H. M. Dowsett, contains all the theoretical information necessary to pass the Postmaster-General's Examination, and the student who masters this volume will find his period of study at a wireless college considerably shortened. There is no need to purchase any other books than the ones you mention, but if you require a good book on Elementary Electricity and Magnetism, we would recommend that by Hadley, obtainable from the Wireless Press, Ltd., at 2s. 10d., post free. A very useful book on Elementary Practical Mathematics is that by Frank Castle, obtainable through the Wireless Press, Ltd. In reply to the last portion of your question, the Marconi Official Records should suit you admirably.

W. B. (Brighton).—The sale of wireless telegraph apparatus is prohibited by the Defence of the Realm Act. The Postmaster-General gives permission in certain circumstances for the use of keys, buzzers, etc., for "non-wireless" purposes, and if you wish to use these we would suggest that you write to the G.P.O. giving full particulars of what you desire to do. You will then be officially informed of what can be allowed.

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Captured German Wireless Sets

1916 Year Book of Wireless Telegraphy

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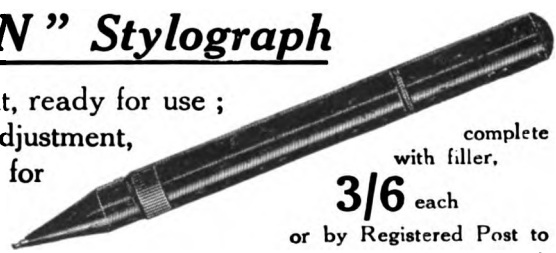

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Contents of Part 1, Vol. IX. 1st April, 1916:—

Long Distance and Cable Telephony (Underground and Submarine). By B. S. COHEN, A.M.I.E.E., and J. G. HILL, A.M.I.E.E.
Secondary Cell Installation for Telegraph Offices. By J. M. FERNANDEZ LAMOTHE, C.A. Rly. Telegraphs, Rosario, Argentine.
Notes on the Design of a Crystal Receiver for Wireless Telegraphy By L B TURNER.
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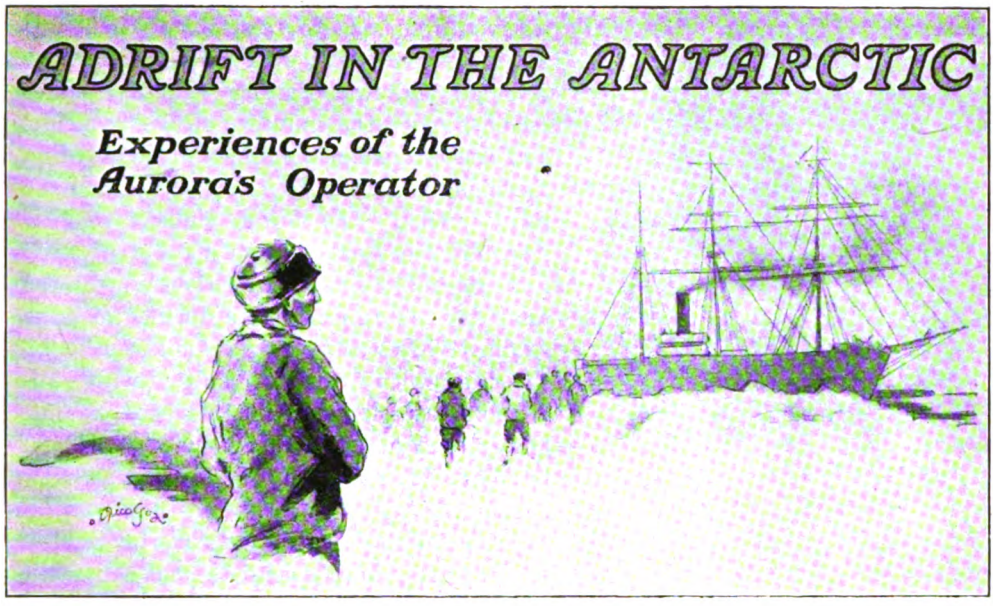

An article transmitted from the Antipodes, and illustrated by J. W. Nicolson.

It is significant of the world-wide interest taken in Polar exploration that, in spite of the terrible and ever-present topic of the war, no small amount of space in the newspapers was recently devoted to the adventures of Sir Ernest Shackleton and the ss. *Aurora*, which was to have picked up the explorer and his comrades. It was the intention of Sir Ernest to traverse the Antarctic Continent from the shores of the Weddell Sea to the shores of the Ross Sea, passing by way of the South Pole. It was calculated that the total distance would be about 1,700 miles. The arrangement was that the intrepid explorer and his party should sail from Buenos Aires in the *Endurance* during the latter part of 1914, and that the *Aurora*, with a supporting party, should leave Australia to pick up the explorers at the Ross Sea. There was also assigned to this ship the duty of laying food depots towards the Pole for Shackleton's use. She was to remain there until March, 1916, and, had all arrangements worked satisfactorily, would have brought him off after his great journey. The first news of the catastrophe was received from the *Aurora* towards the end of March last. The gist of the telegram was to the effect that the *Aurora* had experienced a very rough time in the ice, and her hull had been severely strained. The enormous pressure of the ice also destroyed her rudder, and until a jury rudder could be fixed she was helpless. In addition she lost her anchors, and ran short of fuel. Unfortunately during a great blizzard the ship broke away from her moorings in the Ross Sea, leaving five or six men (who had gone ashore to establish food depots) stranded.

A few days after the receipt of the first telegram, a second wireless dispatch was sent from the *Aurora* as she was on her way from the Antarctic to New Zealand. This second telegram confirmed that there was a fair amount of stores available for the explorers marooned on the Ross Barrier.

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"NIGHT AFTER NIGHT . . . IN HIS CABIN."

A third wireless message was subsequently received from the *Aurora* stating that she was 250 miles south-west of Port Chalmers, New Zealand, and was setting towards Snares Islands, under the influence of the elements, and was incapable of being manœuvred in the high sea owing to damage done to the jury rudder. The Prime Minister of New Zealand (Mr. Massey) immediately arranged for a tug to be sent. In the evening of the same day the *Aurora* sent a further message reading—"Now sailing three knots, all well." The tug, which was specially fitted with wireless apparatus for receiving messages, eventually picked up the distressed vessel, and brought her safely into harbour at New Zealand.

One of the greatest puzzles to wireless telegraphists and scientists alike is the peculiar power some radiotelegraph stations possess of occasionally transmitting messages over many times the distance for which they were originally intended to operate. We are fortunate at being able to include in this article a considerable amount of information received from Mr. Lionel Alfred Hooke, of the ss. *Aurora*, an operator chosen for this important position, not only for his skill in manipulating the apparatus, but also for his versatility and resourcefulness.

The *Aurora*, under Lieutenant Aeneas Mackintosh, R.N.R., was about to leave Sydney, in December, 1914, for her journey to the Great Ice Barrier, where she was to await the arrival of Sir Ernest Shackleton and his party after their journey across the vast Antarctic Continent, where it was suggested that the ship might be materially safeguarded in her perilous journey to and from the ice-fields if she carried a wireless equipment. No sooner was the suggestion made than the people of Sydney with their traditional public-spirited generosity subscribed for the necessary plant. The one purchased was that which proved so useful in the Mawson expedition of 1912–13. There was never any suggestion that this particular installation would be capable of keeping in constant communication with the world at large, but it was hoped, and reasonably so at the time, that with two or three wireless stations operating in the Southern Seas, and a constant stream of traffic between New Zealand and the Straits of Magellan, useful signals might be exchanged on occasions when help might be considered necessary. There was just the remote possibility also that, under "freak" conditions already alluded to, some message might get through to the wireless station established for scientific research in Macquarie Island, and another much more powerful station at Awarua in the south of New Zealand. To assist in this plan the "wireless" operators on ships in southern waters were ordered to keep a look-out for signals from the *Aurora*.

No ship could be less suited for a wireless installation with any pretence at long distance service than the *Aurora*. She is a small craft constructed of wood. Two of

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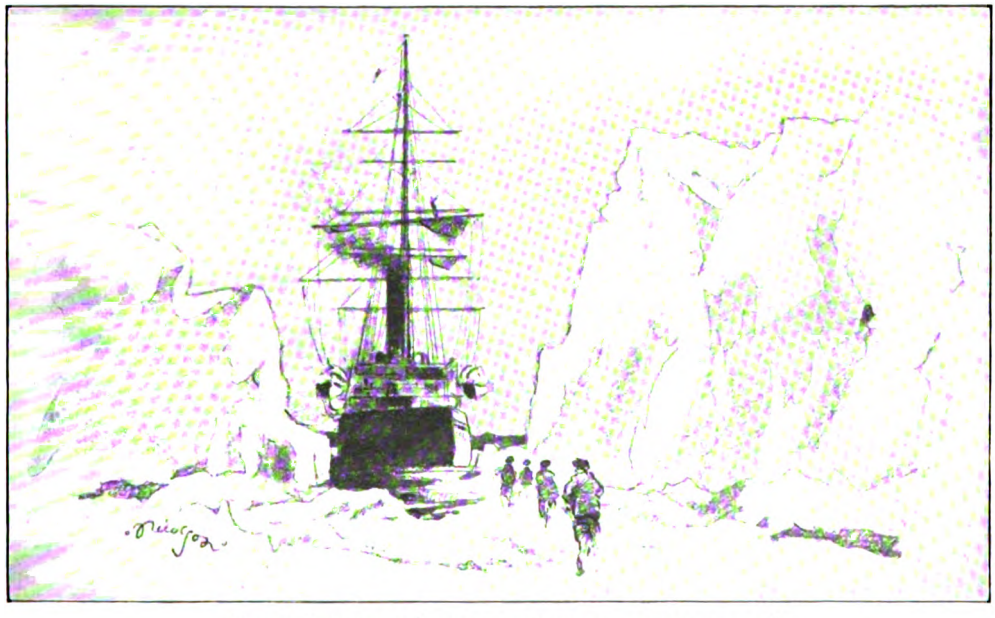
the essentials for effective radiation are lofty aerial and an effective means of getting the electric waves to "earth." The *Aurora's* mast being relatively short and her hull constructed of wood instead of metal, the odds were all against effective working, but by means of extensions to the masts proposed by the manager of the Wireless Company in Australia, and ingenious use of such metal parts as were to be found in contact with the sea water, the installation was given an effective transmitting radius of about 200 miles. The transmitter was of 2-kilowatts capacity, the alternator being driven through a belt from a 10-h.p. De Dion petrol engine. Exceptionally good distances were achieved with this apparatus, and Hooke reports that he was able to keep in constant communication with the station at Macquarie Island until the period of perpetual daylight arrived. As we have already mentioned, the *Aurora* was not the ideal type of ship to achieve best results with a wireless installation, the barquentine rigging proving a hindrance to the fitting of a good aerial. Further troubles were caused by the lowness of the aerial, the maximum height being but 78 feet.

It is well known to those familiar with the elements of wireless that in certain parts of the world and at certain times of the year messages can be transmitted two or three times the distance by night than is possible with the same plant in the daytime. Here, then, was another limiting factor, only to be found, of course, in Antarctic and Arctic regions. Hooke, realising that communication was impossible with the outer world during the summer months, joined the land parties which pushed south for the establishment of food depots for the trans-continental party. In April, 1915, when the summer duties at Cape Evans concluded, the wireless operator prepared to get in touch with the outside world. His experiences in the rigging, endeavouring to add twenty feet to the height of the masts during a blizzard, and with nearly 40 degrees of frost, are described as "terrible." The heightened aerial was completed on May 6th,



"THE 'AURORA' WAS CRUSHED IN THE ICE."

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and then on May 19th the ship's moorings were carried away by irresistible ice floes. Hooke at once endeavoured to get in touch with the marooned party, hoping that they had been able to erect the receiving set landed previously, and it is just possible that the land party now isolated in the inhospitable wastes of perpetual snow learned by these signals of the *Aurora's* ill-fortune, and were able to make the earliest possible provision against an unexpected twelve months on land. At this point it tells us that considerable trouble arose from the insulators, which became conductive on account of ice. As we know that fresh-water ice is an excellent insulator, we can only presume that what it refers to must have been a layer of frozen salt water. Finding that his radiation was reduced to a minimum, Hooke tried smothering the insulators with vaseline, but this apparently made matters worse. He next tried a coating of bitumastic solution, which gave a slight improvement, and he records that Marconi Strain insulators work better minus their cones. Finally, Hooke adopted insulators of the porcelain egg type (see article on Porcelain Insulators in the September and November, 1915, issues) completely coated with a mixture composed of pitch and resin in equal proportions to a thickness of ½ inch; there were no Marconi Strop insulators aboard, the operator says, and he expresses regret on this point, as he believes that these would have been exactly what were required.

[*Photo Newspaper Illustrations.*

SIR ERNEST SHACKLETON, PHOTOGRAPHED A FEW DAYS BEFORE HE LEFT ENGLAND ON HIS PRESENT EXPEDITION

On June 1st Hooke, basing his hopes on the fleeting possibilities of abnormal wireless conditions, commenced to call Australia, but without success. He attributed his total failure to electrical phenomena peculiar to the polar regions, and he made exhaustive experiments with all sorts of makeshifts in the hope of getting definite results. It is well perhaps for Hooke and his fellow adventurers that they did not know the real reason for their non-success, as the hopes of relief which buoyed them until their return might have been shattered.

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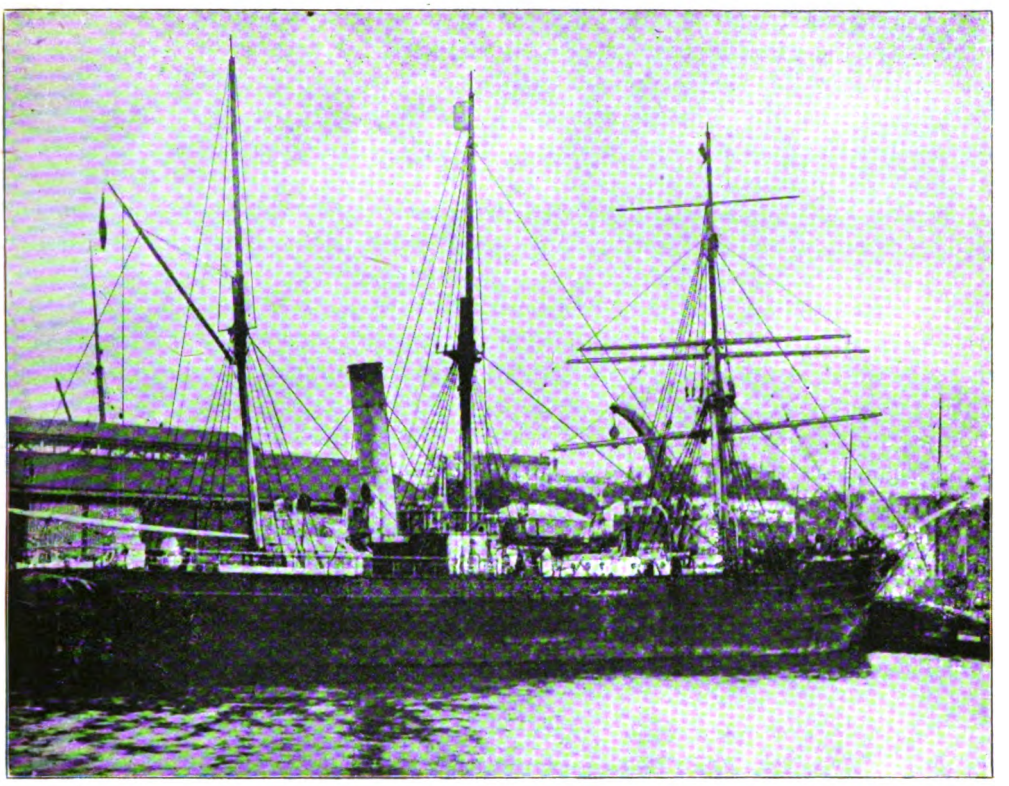

S.S. "AURORA," WHICH WAS TO HAVE PICKED UP
SIR ERNEST SHACKLETON AND HIS COMPANIONS

Here the war was playing the devil's part. In the first place the Commonwealth, in the interests of economy, recalled the staff of the wireless station at Macquarie Island. This removed the first possibility of inter-communication with the little party drifting in the Antarctic ice. Secondly, owing to military reasons, the transmitting apparatus at Awarua was transported to a more distant place, so that had it been possible for the *Aurora*, by a combination of favourable circumstances, to send distress signals as far as New Zealand, she would not have received any reply. Thirdly, by the large reduction of the shipping on the Magellan Straits route all reasonable possibilities of the *Aurora* appealing for help were removed.

Hooke, however, stuck to his post. On July 22nd, 1915, the *Aurora* was terribly crushed in the ice; apparently hopelessly. The boat was then 100 miles from land and 500 from the nearest food depot. Hooke again overhauled his apparatus even to the extent of lowering and re-erecting his masts, in the hope that by so doing he might help those on shore, and his fellows on what appeared to be a doomed ship. Night after night, through long and weary hours, he sat in his cabin with the telephone receivers strapped around his head, straining to catch sounds which would tell of the world's knowledge of their fate and efforts at rescue. Twice he heard faint signals, on August 17th and August 26th, but they were unintelligible—ghostly murmurings of life from a world which might be seen no more.

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Once again there came the blizzard. On September 5th, 1915, the *Aurora* was dismasted, the wireless aerial going with the *débris*. Twice were the triple 280-foot antennæ created by linking up the main mast with ice hammocks, but Macquarie Island remained silent—no one had been left to listen. At the end of February, with the ice breaking, the *Aurora* was freed to drift with her broken rudder.

But the wireless operator's story now changes from sadness to joy. On March 25th, with a quadruple aerial eighty feet above deck, he succeeded in obtaining definite signals from stations in Tasmania and New Zealand, 990 miles distant. Great difficulties were experienced in starting the engine owing, of course, to the cold; but after a glow-lamp had been used and hot water run into the jacket of the engine transmission was commenced, and then followed the message which startled the globe. This message was transmitted 900 miles with an apparatus normally suitable for about 200 miles radius, and eclipsed, for a day at least, the interest in the great world-war. Hooke admits that navigation was greatly assisted on the return journey by the time and other signals received by him from the New Zealand wireless stations.

There are some folk, notably amongst the complex British peoples, who rise to the height of their courage and resource when enveloped in peril and dogged by the factors of disaster. The modest operator on the *Aurora* briefly records that from three days before the *Aurora* broke adrift, whilst the mast extensions were being prepared, he fitted up a 330-foot aerial to one of the huts on Cape Evans with the idea of ascertaining whether the "Aurora Australis"—the "distant" cousin of the Aurora Borealis and one of the most beautiful of nature's pyrotechnics—had any effect on wireless signals. No effect whatever was found. How far these researches, continued throughout the winter, tally with those previously recorded, is a matter for meteorologists and others directly interested to decide. These notes serve, however, to show that even under the most adverse conditions which it is possible to imagine there is a place for wireless, even in Antarctic exploration.

Wireless Association in Holland

WIRELESS specialists, men of science, practical operators, and amateur enthusiasts in Holland have found it possible to co-operate, and have recently formed a wireless association—the "Nederlandsche Vereeniging voor Radio-Telegrafie," with headquarters at The Hague. It has already created for itself a wide field of action; scientific and military committees are being formed, as well as committees for training and examinations, for merchant-naval interests and traffic concerns. Meteorological and agricultural specialists have taken part in the initiation of this body. Owing to the liberality of its patrons, the association will be able to start at once with the establishment of a library and instrumental collection. A monthly publication will form part of the programme.

Among the members of the board of direction are Dr. Koomans, engineer of the telegraph staff, and Mr. L. A. Bakhuis, chief of the cabinet of the Minister of Colonies. The secretary is Mr. J. Corver, van Aerssenstraat 162, The Hague.

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Germany's Early Wireless Stations

SIXTEEN years ago when Wireless Telegraphy was known to a limited public merely as a scientific curiosity, the Germans, with a foresight characteristic of that nation, arranged for the Marconi Company to erect two wireless installations near the mouth of the Elbe.

BORKUM RIFF LIGHTSHIP.

Although these stations were nominally erected for the Norddeutscher Lloyd Steamship Company, there is no doubt that the German Government were highly interested in what they could do, realising even then the strategic importance of such stations for communications with ships at sea.

BORKUM LIGHTHOUSE.

The two stations, one on the Borkum Riff Lightship and the other at Borkum Lighthouse, are illustrated on this page, and although the apparatus was of course crude, compared with that installed in modern stations, yet they worked excellently and served to handle many messages with the giant liner *Kaiser Wilhelm der Grosse*, which, curiously enough, was brought to book by Senatore Marconi's invention early in the War, after the famous vessel had become notorious as a pirate. It is interesting to note that both installations were put in place by Mr. W. W. Bradfield, whose biography and portrait appear in this issue.

The actual apparatus at these two stations has long since been dismantled, other installations taking their place, the station at Cuxhaven together with the well-known station at Norddeich serving to handle the commercial traffic in peace time.

In the piping times of peace the Borkum district is visited by a large number of German holiday-makers who benefit considerably from the fine air and North Sea breezes.

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PERSONALITIES IN THE WIRELESS WORLD

MR. W. W. BRADFIELD, A.M.I.E.E.

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PRACTICAL radio-telegraphy owes much to William Walter Bradfield, whose connection with the Marconi Company dates from September 3rd, 1897, when he entered what was then known as the Wireless Telegraph and Signal Company Limited.

As electrical assistant to Senatore Marconi, he took part in experimental work on Salisbury Plain, and assisted in the erection of the wireless station at the Needles, Isle of Wight.

In the year 1899 Mr. Bradfield installed the first wireless apparatus on British battleships, and a little later took charge of the demonstrations to the United States Government on board the U.S. Battleship *Massachusetts*.

In 1901 he undertook similar demonstrations before the French Government, when communication was established between the French Riviera and Corsica. In the same year he supervised the erection of the famous stations at Siasconset (Nantucket Island) and the Nantucket Lightship.

By 1902 Mr. Bradfield had been offered, and had accepted, the position of chief engineer to the Marconi Wireless Telegraph Company of America, and continued to hold this post until 1908, when he returned to England as deputy-manager of the parent Company and the Marconi International Marine Communication Co., Ltd. In 1910 he became manager of both concerns.

During his tenure of the post of chief engineer of the American Marconi Co. he journeyed to Europe to take part in the now historic first International Radio-Telegraphic Conference, which, it will be remembered, took place in Berlin in the year 1906.

An Associate Member of the Institute of Electrical Engineers, Fellow of the Institute of Radio Engineers (America), and an Associate of the American Institute of Electrical Engineers, Mr. Bradfield follows keenly the progress of every phase of the great science with which he has been so long connected.

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The Special Problems of Aircraft Wireless—VI

By H. M. DOWSETT, M.I.E.E.

The Danger of Fire.

Owing to the use of an explosive gas as a lifting agent which leaks through the balloon envelope, and a liquid fuel from which there is always a certain amount of waste giving off an explosive vapour, all aircraft using either or both of these agents are subject to the risk of fire which must be met and countered by suitable precautions. The possible causes of fire may be grouped under two general heads :—

A. Structural Causes.

B. Physical Causes.

Thus, under A :—

1. Explosion of the gas envelope may occur due to failure of the relief valve apparatus, a very rare occurrence.

2. The explosion which destroyed the Zeppelin L2 at a height of 900 feet above the ground was supposed to be due to a leakage of hydrogen from the balloon into a covered way connecting the two gondolas, which prevented it dissipating into space, and along which it gradually found its way to the exhaust of one of the engines.

3. " Several military airships have been sent up on trial trips with open exhaust pipes instead of being fitted with silencers, or chambers in which any flames could be guarded."*

Under B :—

1. The sudden conflagration which destroyed the Zeppelin L4 on landing is supposed to have been due to a strong spark discharge from its metal frame to earth by way of some trees, which fired the balloon gas, the electric charge having been acquired from the atmosphere when the balloon was flying high.

2. Balloons are known to have been struck and destroyed by lightning.

3. Electric sparks at the wireless transmitting key, and the spark or arc at the H.F. primary circuit discharge.

4. High-tension brushing from the wireless transmitting aerial circuit.

5. Sparks and brushing induced by the wireless transmitting circuit in neighbouring metal work.

We are concerned with the causes mentioned in Group B, each one of which is a form of electric discharge in the atmosphere in the neighbourhood of an explosive gas.

Some knowledge, therefore, of the state of electrification of the atmosphere, of the nature of the electric discharge in gases, and of the conditions necessary to fire an

* Hearne, *Aerial Warfare*, 1909.

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explosive gas electrically, is necessary, if satisfactory methods to combat the danger of fire are to be devised.

THE IONISED ATMOSPHERE.

The whole extent of the atmosphere in which aircraft manœuvre is electrified. In fair weather the vertical potential gradient near the earth averages 2½ volts positive per inch; so that, supposing this gradient to be maintained at high elevations, a metal-framed aircraft ascending, say, to 10,000 feet and acquiring the potential of the air at that elevation, namely, 300,000 volts would—on quickly descending without losing its charge—be capable of sparking to earth over a distance of *nearly 22 inches*.

Obviously measurements of potential at such an elevation are difficult to make and are subject to large errors. It is known, however, that the potential varies considerably from day to day, and at times it certainly reaches a much greater value than the figure given above.

But it takes time for an aircraft to assume the potential of its surrounding medium. An unelectrified metal body with no connection to earth can only be electrified slowly by the bombardment of the ionised gaseous particles nearest to it, which thus release the charge of opposite sign and leave it finally with a charge of the same sign as that of the surrounding medium.

The process of charging—and of discharging—is considerably hastened if the body can, as it were, shed its electrical skin into the medium. Such an action would take place were it to give off gas, the gas carrying the skin charge away with it, and such is the action of the waste gases, the products of combustion from the aircraft engine. The crew themselves, for a similar reason, assist this equalisation of charge.

The same agencies will assist leakage from the body of an opposite or excess charge to that of the surrounding medium, which it may have acquired.

The question of the time required for an unelectrified conducting body which is not connected to earth to arrive at the local potential of the atmosphere, and for the charge to leak back again into space, is one of importance. The generally accepted theory of the sudden destruction of the L4 on landing is, that it descended too rapidly to have given up all its charge, its potential on coming to earth being estimated at 100,000 volts. Even this potential could have been rendered harmless if a metal drag rope had been used to make contact between the earth and the metal frame before the latter itself reached the ground.

It is more safe for an aircraft to assume the potential of the surrounding medium than to remain unelectrified, as a difference of potential above a certain value will give rise to a brush discharge which, under certain conditions, would prove a source of danger. The engine exhaust gases, therefore, act as a form of aircraft electrical safety valve.

THE LIGHTNING DISCHARGE.

A thunder cloud is a fog of highly charged air, each gaseous ion of which has become a nucleus to a water drop. These drops are all separate and tend to remain apart—a jet of water when electrified breaks up into drops—and the insulation through the cloud, if nothing disturbs it, may be of a very high order. It is common knowledge, for instance, that a good porcelain insulator, 2 feet in length, or a 3 feet rubber aerial mast-head insulator, will stand up without difficulty to a pressure of 100,000 volts to

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earth in a rain shower, provided the surface remains in good condition and does not tend to break the drops and make them run together. This is the order of insulation which often obtains in a thunder cloud.

A thunderstorm involves local charges often of enormous magnitude, which result in flashes some of which have been estimated by competent observers to reach a length of as much as six miles. A lightning discharge may take place from a cloud to earth, or from one cloud to another, or between different parts of the same cloud. It may be started by the potential difference being increased above the critical value, or by the insulation resistance between the opposing charges being lowered due to ionisation, or by turbulence—the wind driving one charged cloud into or near the other.

The character of a lightning flash is less that of a sudden and complete breakdown of the air dielectric, than that of one or many small and incomplete breakdowns followed by the main flash which completes the breakdown. There is in fact a trigger action, similar to that well-known method for starting H.F. oscillations in which a small spark discharge ionises the gap and thus releases a much larger spark discharge. For this reason the length of the flash can seldom be used to estimate with any degree of certainty the actual potential involved.

When the relation of lightning to aircraft is considered, one is necessarily obliged to take into consideration the relation of aircraft to these three agencies—ionisation, turbulence, and the trigger discharge—which release lightning. Thus a difference of potential between the metal work of the machine and the surrounding air may lead to brushing on some prominent part, which in its turn may cause sufficient ionisation of the air locally to create a trigger discharge. Again, the turbulence created by the engines and propellers of a dirigible would tend to precipitate a lightning flash. On the other hand turbulence might lead to a silent discharge which would prevent a dangerous accumulation of potential electrical energy.

THE PROTECTION OF AIRCRAFT AGAINST LIGHTNING.

If an aircraft were in the immediate path of the main lightning discharge one could not expect it to survive, but it is very unlikely to be in such a position, as, although thunder clouds gather quickly, they show obvious signs of their presence, and—with the exception of free balloons—aircraft have the power of avoiding their immediate locality.

The danger from lightning lies more in its tendency to create recoil discharges between capacity areas in the neighbouring space. The danger will be reduced, the more the capacity area is reduced, and the more the concentration of the electrostatic field at points, edges, and elongations of all kinds which encourage the brush discharge, is eliminated.

Then if an aircraft must remain aloft in thundery weather, as a measure of safety it should not attempt to use its wireless; instead, the aerial should be wound in-board to reduce the total capacity or conducting extension in space.

It may be possible in certain special cases such as that of the free balloon fitted by Mosler,* or the dirigibles of the Lebaudy class,† to take in also the balancing capacity, but in general this is not possible. The balancing capacity more usually is part of the

* WIRELESS WORLD, January, 1916, p. 650. † WIRELESS WORLD, March, 1916, p. 770.

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airship structure, and as such is fixed. All that can be done is to pay special attention to its design in the first instance, so as to avoid the concentration of charge on it at points and extensions.

The "Brush" or "Silent Discharge."

If we study the initial conditions of an electric discharge from metal conductors in air, as the potential increases—a subject which is closely related to the safe use of Wireless on Aircraft—we find that it takes one of three forms :—

1. A glow which develops into a brush and then into a spark ;
2. A brush, and then a spark, but no glow ;
3. A spark, without any preceding glow or brush.

The glow is characteristic of the first stage of breakdown of the air due to a positive charge, whereas a negative charge first shows itself in the form of luminous beads scattered at intervals along the conductor.

The glow and the beads both develop with increase of potential into the brush discharge.

These three phenomena, generally known as the "corona," are associated with gaps which on the average are more than ten times the radius of curvature of the discharge faces. If the ratio is less than this, the gap will break down by means of a spark only.

Thus a thin wire in space, such as an aircraft aerial, will glow and brush when it reaches a sufficiently high potential relative to its surroundings ; and the coppery glow of a thundercloud may be associated with a brush discharge from its constituent water globules ; but the frame of a Zeppelin, which has been strained by a voyage, when given a charge will have minute sparks passing across the rivet holes wherever the rivets are loose, and there will be no brush in the holes.

Whenever the silent discharge takes place energy is leaving the capacity circuit and is being consumed in the air, giving rise to effects of heat, light, chemical action and ionisation.

With thin wires this loss commences even below the potential at which the wire becomes luminous. As an instance of the amount of energy which can be absorbed in this way one may quote a test made by E. F. W. Alexanderson,* in which he used two wires 40 inches long, ·01 inch diameter, suspended free in air and 2 feet apart. The measureable corona loss first appeared when there was a difference of potential between the wires of 15,000 volts. At a P.D. of 27,000 volts, the loss had increased to 500 *watts*. This energy was not used up in the wires, for they remained quite cold, and it can be shown that they would have fused at less than this value.

The resistance of two such wires at 60° F. would be ·287 ohms. At 1980° F., at which copper melts, their resistance would be about 1·6 ohms. This gauge wire fuses at 16 ampères. Then the C^2R. value at the melting point would be about 410 watts —certainly not more. Thus there would be ample energy available to fire an explosive gas if the potential on conductors immersed in it were allowed to reach a value at which strong brushing took place.

(To be continued.)

* "Dielectric Hysteresis at Radio Frequencies." Institute of Radio Engineers, November, 1913.

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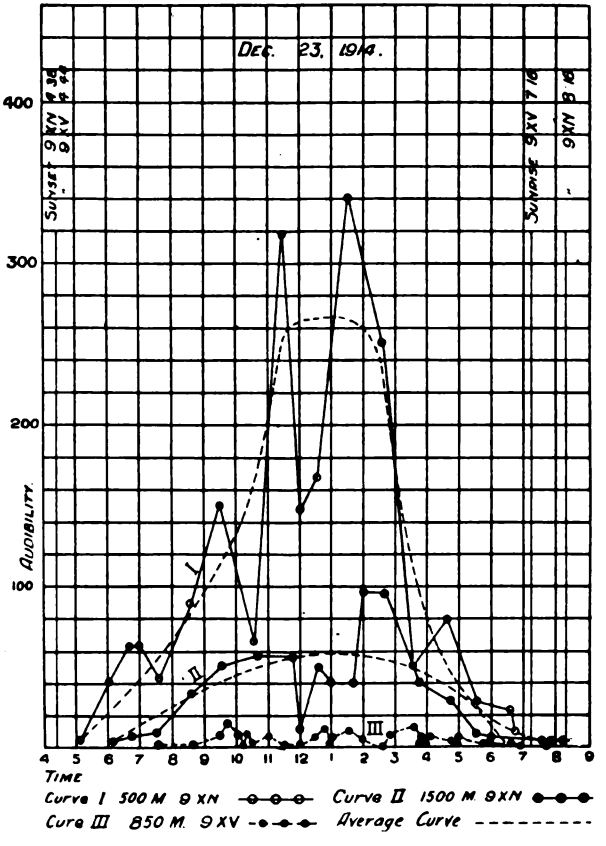
Digest of Wireless Literature

Variation in Wireless Signals.

In the current issue of the "Proceedings of the Institute of Radio Engineers," a highly interesting paper on "Variations in Nocturnal Transmission" is contributed by Messrs. A. Hoyt Taylor and Albert S. Blatterman. Space will not permit us to give full consideration to this important paper, and we therefore have to content ourselves with reproducing a few of the interesting features.



Messrs. Taylor and Blatterman deal with certain experiments in nocturnal transmission carried out by radio stations "9XN" (University of North Dakota, Grand Forks) and "9XV" (Washington University, St. Louis, Missouri), in an attempt to test the interference theory of "fading" and "swinging" effects, and to correlate, if possible, transcontinental weather conditions with radio transmission.

The radiation current at Grand Forks being limited to 13 aerial amperes and that at St. Louis to 7, the observations were necessarily restricted to the periods of twilight and total darkness, and since the distance between the stations is 1,250 kilometres (780 miles), no observations were possible during the mid-summer period of violent strays and bad transmission.

After considering critically the bibliography of wave absorption, the writers describe the apparatus used at the stations and the method of the tests. Observations on signal strength were taken hourly throughout the night with 15-minute periods near sunset and sunrise. Primarily two waves were used by Grand Forks, 1,500 metres and 500 metres with a 2-minute interval necessary to make the shift in aerials and in transmitter connections, as the transmitter is not located in the same room with the receiving and controlling apparatus. After a two-minute rest, the St. Louis wave was observed. The calls were of 3-minute duration. The wave lengths were chosen by both stations of such values as to create a minimum of interference with other stations.

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During part of one test, a seconds ticker was used at Grand Forks for sending the signals, but irregular and rapid sending, usually with an automatic key, was found more satisfactory and less deceptive.

Observations on general transmission conditions from other stations were made from time to time during the night, and an attempt was made in all cases except one, subsequently mentioned, to have the sensibility of the receiver as nearly uniform as possible by checking the audion with a standard buzzer test, set for the desired wave-length, or with a perikon detector of very constant adjustment. It is a matter of regret that the conditions of constant sensibility were not fulfilled at Grand Forks as well as could be desired, inasmuch as two audion bulbs were burned out during the tests, making unavoidable some alterations in sensibility.

* * * * * *

RESULT OF THE TESTS.

The tests were run on the nights of December 23rd, 1914, January 7th, January 28th, March 6th, April 17th and June 10th, 1915. Besides these tests the two stations had a standing appointment for 9.30 and 10 p.m., Central time, on every Monday and Thursday evening until about May 1st, when the St. Louis signals were no longer audible at Grand Forks.

A number of curves are given accompanied by weather maps for the time of the tests. Of these we reproduce herewith Figure 1. Curves I, II, III of Figure 1 present the data of the first test, on December 23rd, 1914. The Grand Forks waves show the greatest regularity in this test, but pronounced fading effects were observed in the St. Louis wave, although it was audible from 7.45 p.m. to 7.40 a.m. Curve I shows the reception of the 500-metre wave, and Curve II the 1,500-metre wave at St. Louis. Curve III shows the reception of the 850-metre wave at Grand Forks.

The extraordinary regularity of the 1,500-metre wave during the first half of the night contrasts sharply with the fluctuations of the 500-metre wave. It is doubtful whether the fluctuations of the 850-metre wave are synchronous with those of the 500-metre wave. Experience has shown that fluctuations may occur so rapidly that tests for reciprocity of transmission must be made almost simultaneously to be of any great value. Further special tests are contemplated on this point.

The 1,500-metre wave shows wide variations between 11.45 and 3.40, which are almost exactly duplicated by the 500-metre wave. This was not due to maladjustment of the St. Louis receiver, as the operator reported that other stations to the south and east sending in this interval showed little change in intensity.

For neither wave do the curves seem to be symmetrical about the solar midnight. Grand Forks reported good transmission from the south and east and fair transmission from the west. St. Louis reported transmission in general not better than the average for mid-winter. Good transmission was reported from south and east.

Enormous variations in the signals of various amateurs in Michigan and Ohio on short waves were reported at Grand Forks and similar results at St. Louis.

The 1,500-metre wave persists well into daylight, being still received at 8.15 a.m. when discontinued. The St. Louis wave, of 850 metres, although varying widely at Grand Forks, was reported at Memphis as fairly steady. [Memphis is about

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250 miles (400 km.) further from Grand Forks than St. Louis and on the same line approximately.]

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TWO KINDS OF FLUCTUATION.

Discussing the results obtained in the tests, the writers say that there seem to be two kinds of fluctuations in nocturnal overland transmission. The first is a rapid fading and the second is a slow swinging in signal strength. The first may be due to changes, in the nature of interference effects. These could be local at the sender or at the receiver, or they might be caused by rather sharp surfaces of discontinuity almost anywhere between the stations.

The second or slower effect may be due to refracting masses of moving ionized air in the path of transmission, producing at times a lens-like concentration and at other times a dispersive effect. It might be contended that all of the fluctuations can be accounted for on this basis.

The presence or absence of true interference effects has a most important bearing on the transmission theories outlined in the first part of this paper. Fortunately the tests seem to throw a little light upon this point.

The generally favourable effect of cloudy days on the following nocturnal transmission is confirmed, thus suggesting that sometimes the conditions causing fluctuations may be at low atmospheric levels.

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THE DISCUSSION.

Amongst those who joined in the discussion following the reading of the paper we find the names of Dr. J. Zenneck and Roy A. Weagant.

Dr. Zenneck said: "It is well known that the received current depends largely "on the decrement of the receiving antenna as well as on the decrement of the trans- "mitting antenna. Both of these decrements are dependent on atmospheric condi- "tions; wet weather, for instance, generally causes a very marked increase in the "decrement of the antenna. Therefore, measurements of the received current are "only comparable if it is sure that the decrements of transmitting and receiving "antennas have remained constant, or if both of these decrements have been measured "and their actual variations taken into account. It is not sufficient to keep "the current at the transmitting antenna constant. I should like to ask Professor "Taylor if he would kindly tell us whether he has taken into consideration the decre- "ments of the transmitting and receiving antennas and their possible changes caused "by atmospheric conditions?"

Professor Taylor: "In reply to Professor Zenneck's suggestion that variation "in the decrement might account for the apparent variations in transmission, I would "like to point out that in wet weather, where one gets abnormally high decrements "and a lowering of energy radiated, we invariably get an improvement in the trans- "mission. In other words, the change of decrement is in the wrong direction to "explain our results. Very large variations in decrement might be shown on an "amateur set with wooden insulators, but with a good sending and receiving set it

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" would be entirely impossible to get decrement variations of a sufficient magnitude " to account for even a small percentage of the changes which we have observed."

* * * * * *

VARIATIONS IN DETECTORS.

Mr. Roy A. Weagant in the course of his remarks said: " My own experience is " that variations due to variations of the apparatus alone are often thousands of times " greater than anything happening in the intervening medium. I do not know of any " commercial form of radio detector, of sufficient reliability, combined with sufficient " sensitiveness to make readings at all quantitative. The audion, with which we " are all familiar, generally changes its sensitiveness from the minute you close the " switch on it. It is not constant in any two consecutive instants, hardly, and not " at all over any considerable period of time. More or less similar remarks are true " of any form of detector in use."

This drew forth from Mr. A. S. Blatterman (one of the authors) the following: " I " must take exception to Mr. Weagant's remarks in which he would dismiss all idea " of swinging and fading in transmission and lay it to irregular detector action. We " are quite sure that our curves are not plots between detector sensibility and time. " Personally I have observed the fading effects for about seven years with a great " many different detectors, the electrolytic, the crystals and the audion, and if " intelligently handled and tested from time to time it is a practical certainty that " variations in sensibility are totally inadequate to obscure the changing conditions " between stations. Moreover, one frequently hears the signals from one station " getting stronger while those of another are fading out, which shows pretty positively " that the detector is not to blame. If Mr. Weagant really believes that irregular " detector sensibility overshadows the changing meteorological conditions between " stations, I can only say that he cannot have directed his attention to transmission " at night over land, especially on the shorter wave-lengths."

* * * * * *

ENGINEERING AND SCIENTIFIC RESEARCH.

In a valuable paper on the above subject presented to the Society of Engineers on May 1st, Dr. J. A. Fleming, M.A., pointed out that the great thing to guard against on the part of the student is premature specialisation. He should broaden as much as possible his knowledge of the principles of Chemistry, Mechanics, Physics, Mathematics, and Metallurgy, and he will then be able later on to build up on this foundation. Unless he does lay this foundation he will not be able to follow or assist in improvements. As an illustration of this we may take subjects such as telephony or wireless telegraphy. It is impossible now for anyone to make any really important addition to these subjects who has not a very competent knowledge of physics and some parts of mathematics. The easier problems are worked out and the design of telephonic systems or radiotelegraphic stations has become a matter in which advanced scientific knowledge is an important factor. Then, again, to make any advance in metallurgy requires a very intimate acquaintance with the chemistry of metals. A lucky accident might give a clue to an improvement, but an observer not sufficiently acquainted with modern chemical principles could not take advantage of it or follow it up.

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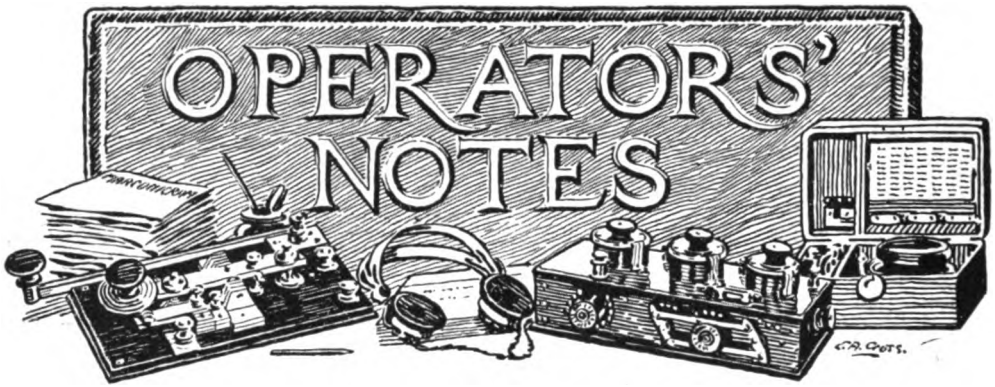
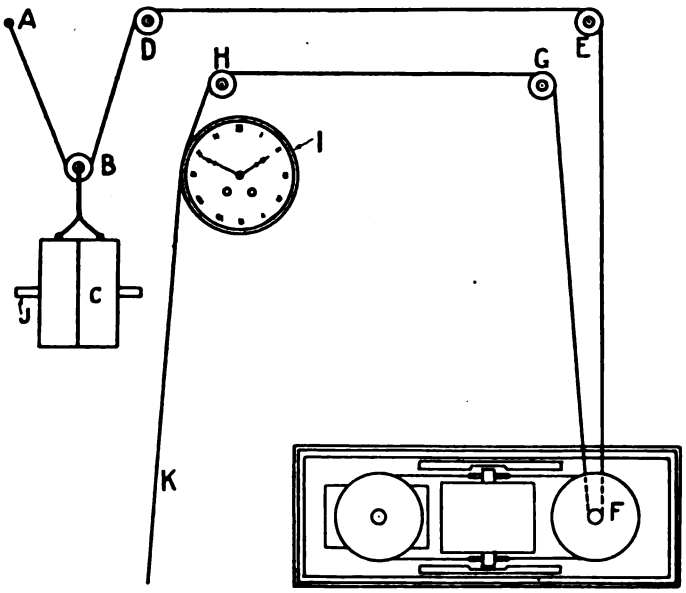


Running a Magnetic Detector Without Clockwork

By E. A. J. DAUBNEY

Editorial Note.—The following account of how a broken clockwork was dispensed with will, we are sure, interest many operators, and will also serve to demonstrate the ingenuity of the operating staff in times of emergency. The Editor invites similar articles from wireless operators explaining how they have overcome their practical difficulties. All such articles as are accepted will be paid for.

WHEN the magnetic detector broke down I took out the entire spring and barrel. On the spindle just behind the driving pulley I fixed a piece of sand-paper, and then replaced the detector in position on the partition. Four pulleys were fixed in the ceiling, two immediately above the detector and two as near the adjoining bulkhead as possible. These pulleys were made from small insulators with staples bent to serve the purpose of spindles as well as fixing, and were procured from the electrician. Two old dry cells were then tied together for the weight (C) and a cotton reel (B) fixed to them by means of stout copper wire, upon which the reel could revolve freely. A piece of wood (J) was fixed to the cells, and this kept them steady against the bulkhead and prevented them from turning when the ship rolled. One end of a piece of cord was secured at A, the other being taken round the reel (B) over pulleys D and E, then round the spindle F, and



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back over pulleys G and H; the loose end resting round the clock. The sand-paper on spindle prevented the cord from slipping and the weight exerted a gentle pull which caused the detector to revolve. I left the fan inside of detector, and this regulated the speed as it does with the spring. It took three-quarters of an hour for the weight to reach the floor of the cabin. All that was then needed was to lift weight in one hand, pull cord at K. This brought the weight again to the ceiling. We found that the slight resistance caused by the cord passing round the clock was quite sufficient to keep cord tight enough to prevent slipping at F. Although everything was done in a crude way, it worked beautifully, and we suffered but slight inconvenience.

Manchester School of Technology

WE have just received a copy of the Manchester Municipal School of Technology's prospectus for the Summer Evening Classes for 1916, and a very interesting prospectus it is. Mechanical and Electrical Engineering, as would be naturally expected from the fact that the classes are located in Manchester, occupy the predominant positions, although classes on municipal and sanitary engineering and architecture, besides chemistry and chemical technology, run them hard. In view of the conditions which are rightly to prevail after the close of the war, such opportunities for studying the theoretical side of practical industries like that of the textiles, of mining practical geology, and confectionery should be welcomed by those young Englishmen who are devoting their life's work to the practical branches of this subject. From the point of view of workshop and practice, the English have always more than held their own. But our German competitors have in the past obtained a distinct lead in the field of theoretical study, and this must not be the case in the future. The Municipality of Manchester sets an excellent example, and we should hope that it may prove true, in this instance at all events, that—as the old Midlands boast runs:—"What Manchester thinks to-day England thinks to-morrow."

Share Market Report

LONDON, *May 12th*, 1916.

THERE has been a steady demand for "Wireless" shares since our last report, and, with the exception of the American Company, there has been an appreciation in prices. Marconi Ordinary, £2 3s. 9d.; Marconi Preference, £1 18s. 9d.; American Marconi, 14s. 6d.; Canadian Marconi, 8s.; Marconi International Marine, £1 6s. 3d.; Spanish and General Wireless Trust, 6s.

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"The Year Book of Wireless Telegraphy and Telephony, 1916"*

A VERY practical method of arriving at the various stages of progress made by any science is that of studying the evolution of its literature. A general sequence is almost invariably followed.

A Darwin, a Newton or a Faraday reads a paper before a learned society, or startles the scientific world by some epoch-making treatise. This exposition brings forth from other scientists revelations of their own research. They narrate the results they have obtained and the methods they have followed. These methods are co-ordinated with those of the great discoverer, and thus a new science is born.

The next step is probably marked by the appearance of scientific volumes, closely followed by reviews, articles, and correspondence in the learned journals and magazines. The final stage is not reached until some practical application of the new science arrests the attention of the general public. Then popular volumes follow in rapid succession. The regular periodicals devote increasing space to it, and finally an annual book of reference is brought out, collating and putting into readily accessible form the latest information with regard to every branch of the subject.

Some of these books of reference restrict themselves to mere cut-and dried lists of facts, tables, and formulæ, and restrict their sphere of usefulness accordingly. Others travel outside these boundaries, and include popular expositions of the latest phases of those branches which are attracting current attention. Such volumes base their right to public appreciation on a double foundation, and it is amongst this class that must be included the *Wireless Year Book* which has just been published.

It does not afford any proof of the firm establishing of wireless telegraphy. This practical science, though born but twenty years ago, has long outgrown that stage of development ; but the appearance of a fourth annual issue of so substantial a volume, in an edition of 10,000, *does* constitute a very clear indication of the world-wide interest taken in the subject.

In view of the volume's established popularity it would appear necessary to make some apology for referring in detail to some of the regular items, which have already proved their value. Later on reference will be made to the new sections ; but, for the moment, it will be best to deal with a rapid survey of those regular features which form the mainstay of the book.

In a brief foreword the editor justifiably refers to the pride felt by the publishers in bringing out such a volume at such a time. Only those intimately concerned with the compilation of reference books can appreciate the difficulties of editor and publishers alike, ranging from shortage of labour in the printing world and the ever-present paper trouble, to difficulties connected with the "Defence of the Realm Act."

It is a very happy idea to give as the frontispiece a portrait of Senatore Marconi in the uniform of a lieutenant in the Italian Army, and many thoughts are inspired by

* *The Year Book of Wireless Telegraphy and Telephony for 1916.* Published by the Wireless Press, Ltd. Price 3s. 6d., or post free 4s. inland and 5s. abroad.

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this handsome picture of the gallant officer who has contributed so potent a weapon for the present fight for liberty.

From the perusal of a well-compiled calendar we turn to the standard feature :—" A Record of the Developments of Wireless Telegraphy," in which—under the various years—we find a *précis* of the events leading up to Senatore Marconi's discovery and an account of the leading points of interest in connection with it, chronologically treated. This section of the Year Book has proved so valuable, that one of the magazines in the Far East actually brought out a " Wireless Telegraphy " number, devoting more than half of the magazine to a reprint of this part of last year's issue. This year many additions and revisions have been made, and a glance over the pages devoted to 1914 and 1915 brings home vividly to the readers the gradual, though sure, collapse of Germany's world scheme of wireless communication.

The portion of the volume devoted to the laws and regulations of the various countries has received the addition this year of a valuable index, facilitating reference in a high degree. Thus, if we require to ascertain what are the responsibilities of shipowners with regard to Wireless Telegraphy on Danish vessels, or what restrictions are imposed in Trinidad, we have but to glance at the index to trace the required page in a moment. Needless to say, the laws and regulations themselves have been brought up to date, as far as present war conditions will allow, and this applies also to the list of wireless telegraph stations of the world which follows this section.

Thousands of copies of the year book are used in all parts of the world by people who need to turn up particulars of call letters, ship stations, shore stations, and rates, and we would remind new readers that the possession of a copy of the year book places in their hands a complete and up-to-date list of all the land and ship stations, with their rates, call letters, hours of service, range, wave-lengths, and other valuable particulars.

A welcome feature in each edition consists of a number of special articles contributed by well-known men, and dealing with various phases of wireless telegraphy and telephony. This year these articles alone are worth far more than the cost of the whole volume. For instance :—Mr. Archibald Hurd, the well-known naval writer, contributes a valuable article on *Intelligence in Naval Warfare*, a highly interesting history of the various means of signalling in the Navy. The difficulties of signalling before the days of wireless are vividly brought home to us, and when speaking on this point Mr. Hurd quotes from the life of Howe as follows :—" Now, my dear Kempy, " do, for God's sake do, my dear Kempy, oblige me by throwing your signals overboard, " and make that which we all understand, ' Bring the enemy to close action.' " Dr. J. A. Fleming, M.A., F.R.S., writing on *Photo Electric Phenomena*, a subject to which he has devoted considerable attention and research, reveals to the reader many vital and interesting facts concerning light, electricity, and the earth's atmosphere. He mentions in the course of his article that one cubic mile of sunlight near the sun's surface contains energy sufficient to throw twenty of H.M.S. *Elizabeth's* fifteen-inch shells over the top of Mont Blanc. Let us be thankful that the welcome rays of sunlight, which fall upon us here, have at least been tempered in their effect before reaching London ! Colonel F. N. Maude, C.B., contributes an article entitled *The Allies' Strategy in* 1915 ; whilst the world-wide reputation of Dr. W. H. Eccles will secure many readers of his most valuable article on *Capacitance, Inductance, and Wave-length*

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of Antennæ. The diagrams (known as "abacs") which accompany his text enable various ratios to be read at a glance, whereas until recently these were only obtained by mathematical calculations, involving great care and considerable difficulty. To the general reader a contribution by Mr. H. J. B. Ward, B.A., on *Wireless Waves in the World's War* will be especially welcome, containing as it does a general survey of war happenings affecting radiotelegraphy. In writing on *The Problems of Interference* Mr. P. W. Harris points out the difficulties which confront the practical wireless man, and the reason why so many of the patents which endeavour to solve the difficulties of "jamming" are valueless.

A valuable article devoted exclusively to the *Progress of Radio Telephony in U.S.A.* serves to inform the reader of just what has been done in that country, and what may be expected in the future. With regard to research, the report of the Committee for Radiotelegraphic Investigations of the British Association will be welcomed by many experimenters, as well as the contribution under the title of *A Measurement of Signal Intensity*, by John L. Hogan, jun., the well-known American investigator.

Now that long-distance wireless services have been established in many parts of the world, we are glad to see in the Year Book a brief outline of radiotelegraphic progress in this direction, in which the significance of the much discussed Imperial scheme is touched upon. International time and weather signals, the Report of the Committee of Standardisation of the Institute of Radio Engineers, and a large section devoted to useful data merit a word of praise, whilst the section on useful formulæ and equations has been thoroughly revised and brought up to date by Dr. J. Erskine-Murray, the well-known radiotelegraphic investigator and lecturer.

A feature of great value appears as usual in "Wireless Telegraph Patents in 1915," and this is followed by particulars of leading companies engaged in the commercial development of wireless telegraphy. A word of commendation must also be given to the sections devoted to biographical notices and the literature of wireless telegraphy.

The map of the world, on which will be found the land stations referred to in the list of wireless stations already mentioned, has, like the other section, been brought up to date.

So far we have made no mention of the excellent illustrations on art paper which are interspersed throughout the text. Of these there are thirty, many being portraits of well-known men in the world of wireless, whilst others depict stations and apparatus. Special interest attaches to the plate facing page 624, which shows some of the brave wireless operators who have performed their duty in the face of great peril.

This edition of the year book shows a great improvement upon the last issue, excellent as this undoubtedly was. The printing and general production is all that could be desired, and is certainly far better than that of many of the other well-known annuals which come before us from time to time. It only remains for us to state, and we are sure that all those who have previously made acquaintance with the *Wireless Year Book* will bear us out, that this volume is indispensable to every man or woman whose interest in wireless telegraphy is anything more than superficial. In spite of the substantial increase in cost of production, the price remains at three shillings and sixpence.

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Administrative Notes

Argentina.

According to the *Revista Telegraphica* of Buenos Aires there has recently been opened to public service a new radiotelegraph station at Rio Grande in Tierra del Fuego.

Australasia.

The following rates will be charged on messages :—

(*a*) From ship stations for delivery in the Commonwealth and relayed through the new stations in the Pacific Islands :

Via	Land Line Charge.	Radio Relay Charge.	Coast Station Charge.	Ship Station Charge.
Kawieng (New Ireland)	1d.	Plus 4d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Kieta (Bougainville, ...	1d.	Plus 3d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Madang (formerly Wilhelmshaven) ..	1d.	Plus 3d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Nauru	1d.	Plus 3d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Port Moresby, New Guinea	1d.	Plus 2d.	Plus 3d. for ships whose rate is 2d. per word.	Plus 2d.
Port Moresby, New Guinea	1d.	Plus 2d.	Plus 6d for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Rabaul (New Britain)	1d.	Plus 3d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.
Woodlark Island	1d.	Plus 2d.	Plus 3d. for ships whose rate is 2d per word.	Plus 2d.
Woodlark Island	1d.	Plus 2d.	Plus 6d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.	Plus 4d.

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(*b*) For messages to and from ships at sea for delivery within the Islands, viz. :

	Coast Station Charge. per word	Ship Station Charge. per word	
For ships licensed in Australia and New Zealand	3d.	2d.	Plus delivery charges, if any, to be collected from addressee.
For other ships	6d.	4d.	

(*c*) The following is a list of approved rates for wireless messages between the Pacific Islands, viz. :

	Per word.
Nauru to Kieta *via* Woodlark Island	3d.
Port Moresby to Kieta *via* Woodlark Island	3d.
Port Moresby to Nauru *via* Woodlark Island	3d.
Port Moresby to Rabaul	2d.
Port Moresby to Wilhelmshaven	2d.
Rabaul to Nauru *via* Woodlark Island	3d.
Rabaul to Kieta	2d.
Rabaul to Wilhelmshaven	2d.
Wilhelmshaven to Kieta *via* Rabaul	3d.
Wilhelmshaven to Nauru *via* Woodlark Island and Rabaul	4d.
Woodlark Island to Kieta	2d.
Woodlark Island to Nauru	2d.
Woodlark Island to Port Moresby	2d.
Woodlark Island to Rabaul..	2d.
Woodlark Island to Wilhelmshaven *via* Rabaul	3d.

Delivery charges (if any) to be collected from addressee.

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The Radio-Telegraph Service of the Australian Federation will in future be administered by the Department of the Navy, and this Department, therefore, begs that from now onwards all correspondence concerning this service shall be addressed to the "Naval Secretary, Department of the Navy, at Melbourne, Australia."

Chile

In view of the fact that various wireless stations have been established in this country, and that several are already connected to the State telegraph lines, the following decree has been issued by the Government authorising the use of the wireless stations for commercial purposes :—

1. The State Telegraph Office will have under its control the radio-telegraphic stations in as far as the public service, collection of tariffs, payments and relations with other countries are concerned. The naval authorities will continue having under their control everything relating to operators, apparatus and similar services.

2. The Wireless Offices will be given over to the public service as and when the State Telegraph Office shall decide, beginning with the stations already connected to the State telegraph lines, which are those situated at Valparaiso, Antofagasta and Punta Arenas. The others will be put into service as soon as the necessary connections are made with the telegraph lines.

3. In accordance with the International Convention the charges will be :—

(*a*) To the coast station, 60 centimes.

(*b*) To the ship station, 40 centimes.

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(*c*) The charge for transmission over the lines of the telegraph system, 10 centimes.

(*d*) The transit charges of the intermediate coast or ship stations and charges appertaining to special services required by the sender.

4. The State Telegraph Office will fix the following tariff for messages :—

(*a*) Radio-telegrams sent to ships from coast stations, $5.50 gold of 18d. for the first ten words and $0.55 gold of 18d. for each additional word.

(*b*) For radio-telegrams sent between Chilian coast stations, $4 currency for the first 10 words and $0.40 currency for each additional word.

(*c*) For radio-telegrams transmitted to any State telegraph office from on board Chilian warships by the officers or crew, $2 currency for the first 10 words and $0.20 currency for each additional word.

(*d*) If, in order to reach their destinations, messages have to pass over the lines belonging to other companies or administrations, additional charges corresponding to said lines will be made.

(*e*) Press telegrams will be sent with a rebate of 50 per cent.

The only persons who may send messages gratis are the President of the Republic, the State Ministers when referring to Government matters, the heads of the Navy, commanders of warships, and the Director-General of Telegraphs.

The service will comply with the regulations of the London Radio-telegraphic Convention of July 5th, 1912.

Before this decree was issued permitting the commercial use of the wireless stations, all messages for Punta Arenas had to be sent across the Andes to Buenos Aires, and thence *via* the Argentine lines, which necessarily caused many delays. This is another case in which wireless has come to the aid of the business man by helping to bring the southern part of Chile into closer commercial relations with the important agricultural and industrial region of the central valley, in which Santiago, the capital of the Republic, is situated.

Pacific Islands.

King Island Radio Station was opened on February 14th at 9 a.m. for the transaction of public business. The station is not yet completed, but in order to provide radiotelegraphic means of communication between King Island and the mainland as early as possible, a portable wireless installation was forwarded, and has been installed pending the installation of the proper apparatus. Up to the present time King Island has been isolated, and has not been provided with any means of communication with the mainland. Particulars of rates, hours, etc., follow :

For ordinary telegrams, 1d. per word, with a minimum charge of 1s. per telegram, plus ordinary land line charges ; deferred cablegrams half the rate for ordinary telegrams. Week-end cablegrams, quarter the rate for ordinary telegrams. Press telegrams not exceeding 25 words, 1s. 3d. ; exceeding 25 words, but not exceeding 50 words, 2s. 6d. ; exceeding 50, but not exceeding 100 words, 5s. ; additional 50 words or portion of 50 words, 2s. 6d., plus Commonwealth land charges for press telegrams. Rates for ship traffic in accordance with wireless telegraph regulation No. 23 of Post and Telegraph Guide.

The hours of service are 9 a.m. to 6 p.m., Monday to Saturday, with no service on Sundays.

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The rates for Flinders Island Radio have been altered to correspond with the rates for King Island, as set out above, as from February 14th.

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A powerful wireless station is being erected in the Solomon Islands. The work will probably be completed in three months. Delay has occurred owing to the scarcity of labour. The islanders have for some time past been relying on the steamer *Kulumbangra* for their urgent news, as this vessel has an up-to-date wireless installation on board. It was found useful to the authorities in the early stages of the war.

Spain.

The following is an extract from *Boletin Oficial del Cuerpo de Telegrafos*, Madrid, dated February 1st, 1916:

"From time to time the General Direction of Telegraphs in Spain has noticed "the extraordinary frequency with which claims arise regarding the non-delivery of "radio telegrams to addressees, and regarding delivery so very much delayed as to "render them useless; and, what is still more to be regretted, these troubles nearly "always have their origin on the land lines, in spite of what has been recommended "in circulars from time to time, and also by numerous communications sent by the "Department to the stations which handle this service, but especially the Cadiz, "Teneriffe and Vigo stations.

"In view of the disregard of what has been communicated, the General Direction "finds itself obliged to advise chiefs of sections and the staffs under them that it feels "disposed to apply Article 56 of the Regulations of the Telegraphic Service in all "its rigour so that the devolution of the amounts collected from the charges paid by "the senders of messages shall not be borne solely by the treasurer."

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According to the *Shipping Gazette* a new wireless telegraph station is in course of erection in the Naval yard at Ferrol.

United States.

The superintendent of the Naval Radio Service announces that, commencing from last March, a complete communication chart is issued to the public, gratis, upon request. This chart includes the various merchant vessels in the North and South American trade, the time and date they may be reached by wireless telegraphy, the coastal stations through which the traffic should be sent, and the rates for radio landline services.

It is notified that the wireless station at Key West, Florida, is open to commercial traffic, and handles ships' position reports, which are forwarded to the *New York Herald* not later than 8 p.m.

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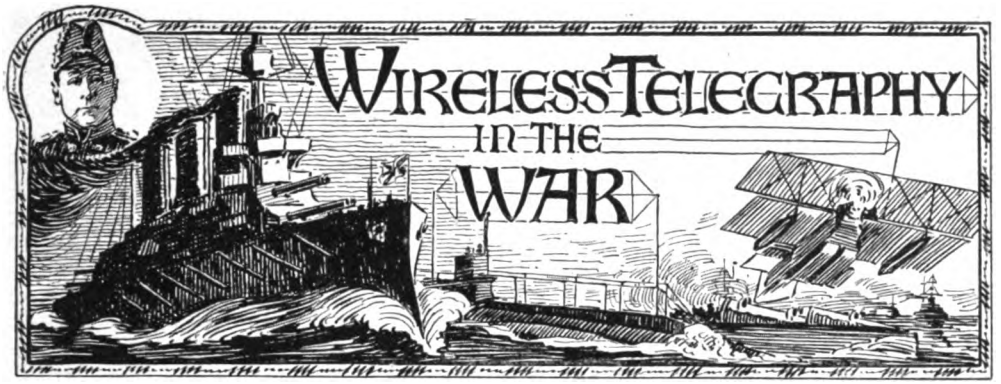

IMPRESSIONIST SKETCH OF A BRITISH ADMIRAL.

A series of articles which have appeared in the columns of the *Times*, from the pen of a writer who has been serving with the Grand Fleet, contains many delightful pictures of that side of Britain's war activities. A recent sketch of the duties which fall to the lot of a British admiral must enlist the sympathies of every Englishman, for all of our hearts are always ready to go out to those who have business in the great waters.

We read of the "stormy time" always in store for the admiral whenever he is in harbour. The wind and sea may be calm outside, but within the white enamelled walls of his state room, there rages a never-ceasing tempest of paper. Reports, despatches, memoranda of all descriptions blow in upon him in fitful gusts, and it is only during his twenty-four hours day at sea that he really feels himself free from stormy troubles. It is true that even then his Commander-in-Chief keeps in constant radio-telegraphic touch, whilst that "strange and inscrutable providence," the Admiralty, possessed of high-power wireless apparatus, directs all his doings, watching and listening to him night and day. But after he has exchanged his warm and luxurious sleeping cabin in the after quarters for his sea cabin, high up on the superstructure which clusters round the fore-mast; after his course and speed have been decided for the night, he is likely to be undisturbed by unnecessary communications. The flag lieutenant may occasionally pop his head in the door, and deliver various items of information; but nothing merely vexatious is likely to be received in the small hours, and the admiral may rest in peace.

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"TRUTH" STRANGER THAN FICTION.

Our distinguished contemporary in a recent number, after stating that the war had been in progress long enough for the Admiralty "to have digested the various "problems arising out of the use of wireless," proceeds to demonstrate that his own digestion is slightly dyspeptic! Some one appears to have been alarming the mirror-holding goddess with dreadful stories about enemy familiarity with British Naval Codes. She appears to view with misgiving the fact that the constant "touch" maintained between the British Admiralty and the Commander-in-Chief Afloat is kept up by wireless, a form of communication which employs "the universal aether." Our Divinity, therefore, with truly feminine illogicality, advocates the laying of "A

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THE "MIRROR-HOLDING" GODDESS IS FRANTICALLY ALARMED!

"cable telephone, or "even a telegraph "wire"! and delivers a little homily on the absurdity of employing "a costly staff "whose sole business "it is to be continually "constructing new "codes, which are de-"ciphered by the "enemy, and thereby "rendered useless and "dangerous, almost as "soon as they come "into operation."

We wonder what the Commander-in-Chief Afloat would say to the *Truth* proposal? Would he be expected to remain continually at anchor by the side of the terminal of the precious wire? or has some genius invented a flexible cable which can be dragged about by the flag-ship? Let us suppose for a moment that the problem has been settled upon one of these two alternatives: is the "costly staff" engaged on "continually constructing new codes," immediately dispensed with by this *Truth* expedient? Of course, it is very annoying that our enemy should be so ingenious as to readily decipher codes, but it seems a little hard on him to confine our high opinion of his ingenuity to this single qualification. Nothing is easier, as far as land telegraph lines are concerned, than the process known as "tapping," and is there any reason to doubt that enemy submarines would be able to extract from *Truth's* cable all the information it wanted, and then cut it? No! Our contemporary has in this instance not displayed the acumen which usually characterises him; he has credited the Germans with too little enterprise in the way of cable "tapping" and "cutting," whilst crediting them with too much in the way of code decipheration. We can assure him that British Admiralty codes are by no means the easily solved "jig-saw puzzles" which he imagines; we might enlarge on the subject, but—with the Whitehall censor before our eyes—think it well to refrain.

This question of secrecy is one which has, ever since the advent of wireless telegraphy, been constantly employed by the "vested interests" who hold the field with

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regard to overseas and trans-ocean cables. It is a bogey which, like the great sea serpent, continually crops up under various forms in the columns of the Press. Even if there were anything in it, any whist player of experience knows perfectly well that it is far more important that you should acquaint your partner with the state of your own hand rather than follow such rules of play as will mystify him as well as deceive your opponents.

* * * * * *

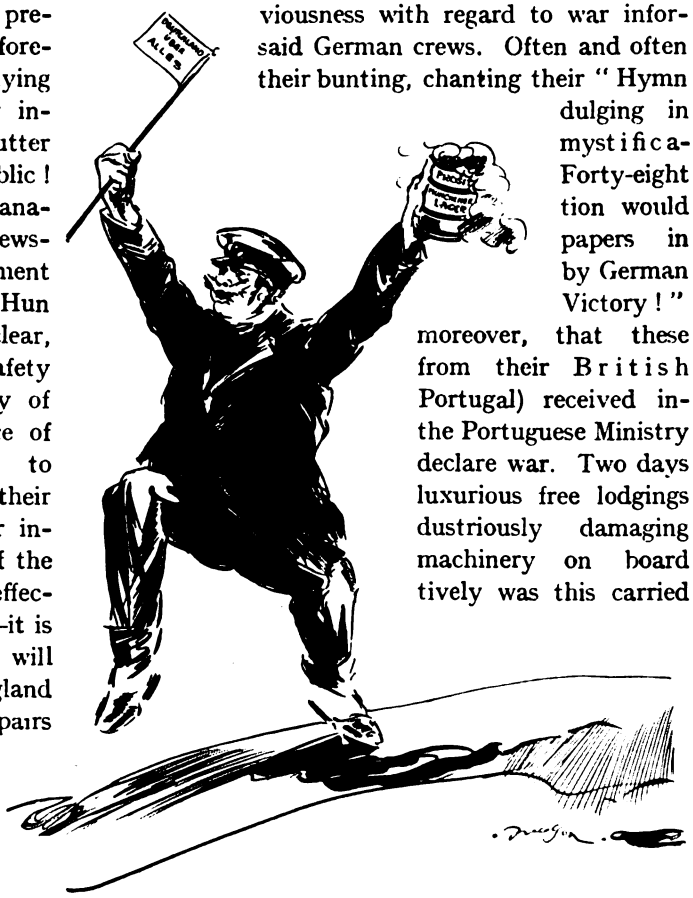
Perfidious and Unwelcome Guests.

The Iberian Peninsula has all through this war been swarming with German visitors. Very unpleasant and troublesome guests their Spanish and Portuguese hosts have found them! One of the effects of the declaration of war by Germany upon Portugal has been that the smaller country at all events has been able to free herself from the incubus. A correspondent, writing from Lisbon on the subject of the German crews of the interned vessels recently taken over by the Portuguese Government, comments upon the fact that German residents in Portugal have all through the war been, from time to time, caught using surreptitious wireless apparatus at night, and—when questioned about it—have made the almost invariable excuse, that it was merely a piece of toy apparatus. It is to such apparatus, however, that is most plausibly attributed the remarkable premation possessed by the aforethey have been observed flying of Hate," and generally ingala festivities, to the utter tion of the Portuguese public! hours or so later the explanaappear in the Lisbon newsthe shape of the announcement agencies of a great "Hun

It is abundantly clear, guests (who owed their safety enemies to the neutrality of formation well in advance of that Germany intended to before the event they left their and fled to Madrid, after inthe most vital portions of the their own vessels. So effecout, that—in some cases—it is believed that the ships will have to be towed to England before the necessary repairs can be carried out.

* * *

viousness with regard to war inforsaid German crews. Often and often their bunting, chanting their "Hymn dulging in mystifica-Forty-eight tion would papers in by German Victory!" moreover, that these from their British Portugal) received inthe Portuguese Ministry declare war. Two days luxurious free lodgings dustriously damaging machinery on board tively was this carried



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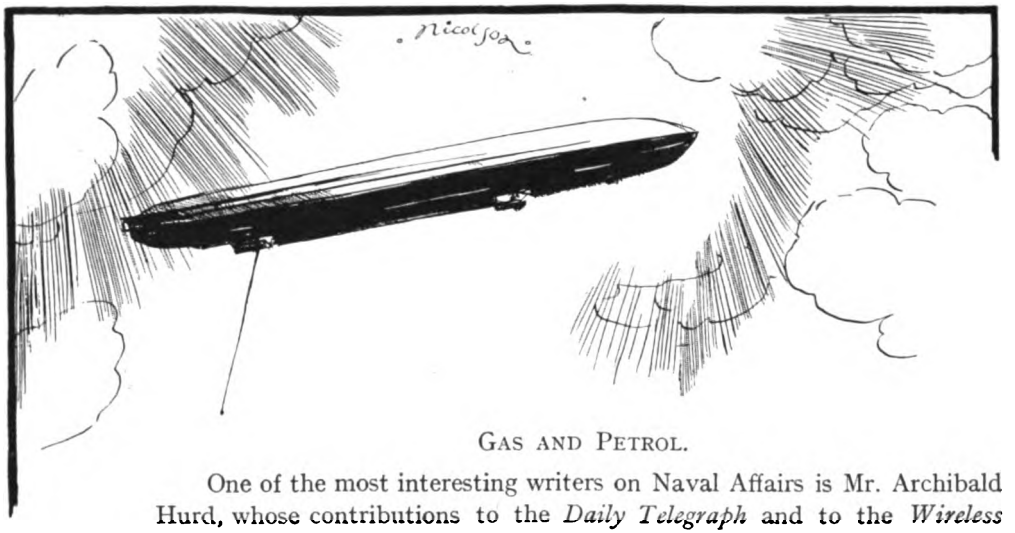
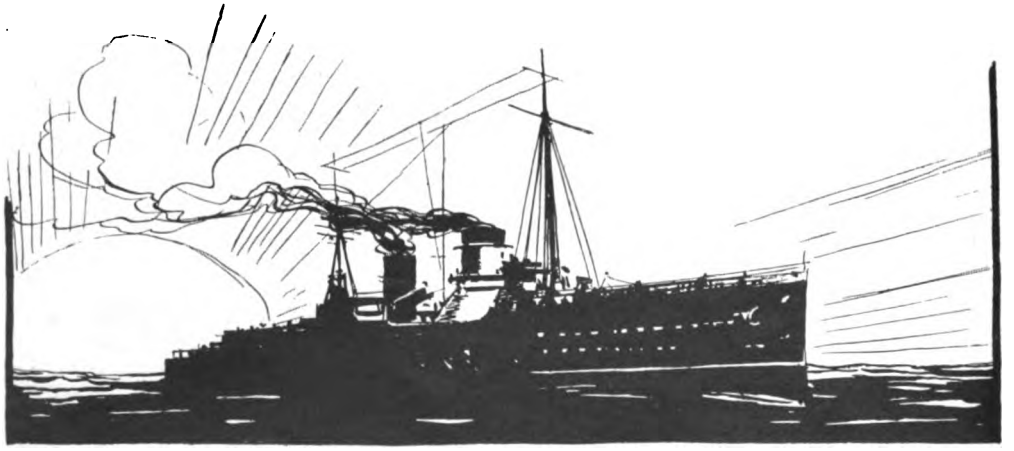


GAS AND PETROL.

One of the most interesting writers on Naval Affairs is Mr. Archibald Hurd, whose contributions to the *Daily Telegraph* and to the *Wireless Year Book* are probably well known to our readers. In one of his recent articles he dwells upon the advantages bestowed upon our enemy by his possession of the highly developed "lighter than air machines," which we know as Zeppelins. Their proper and legitimate sphere of action is that of scouts, for which the wireless apparatus which the later machines are capable of carrying renders them specially efficient. From these aircraft, flying at a great height completely out of gun range, the North Sea can be viewed as though it were one vast panoramic theatre. They can scan all the more important operations, and by means of radio-telegraphy can report where British men-of-war are to be met with and where they are not. It must be remembered, too, that a Zeppelin can travel at about twice the speed of the fastest warship afloat. The British Fleet was unprovided with these rigid dirigibles at the commencement of the war and is handicapped to this extent.

On the other hand, of course, although the British do not possess Zeppelins, their seaplanes are both more efficient and numerous than any equivalent machines possessed by the enemy; and although, constructionally, they are not able to carry such powerful wireless apparatus as is possessed by the later type of "gas-bag," they are utilised



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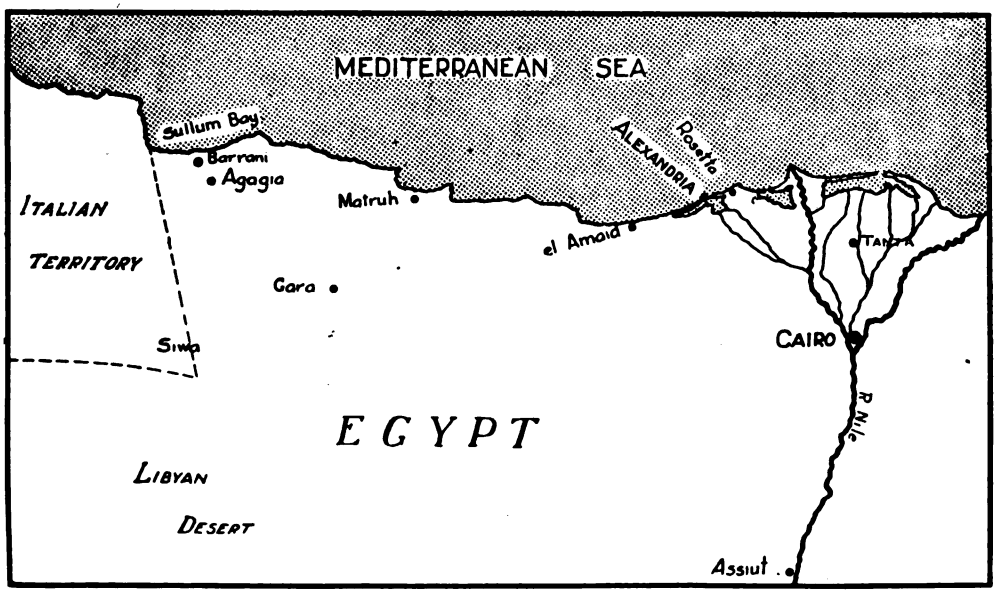
from floating bases, and, therefore, do not require to report direct for such long distances. The exploits of British seaplanes, like those of British submarines, have been far more numerous and important than the general public has been able to learn through the medium of the Press. It is only now and again that a glimpse at their activities is vouchsafed, a notable instance being the occasion when a combined naval and seaplane excursion delivered an attack upon the German airship sheds in Schleswig-Holstein at the end of March.

On the whole, the ceaseless vigilance, which wireless telegraphy enables the Fleet to maintain, gives these islands a defensive screen such as they have never possessed in past ages, and the rarity even of abortive attempts, like the recent bombardment of Lowestoft and Yarmouth, demonstrates that the enemy is fully aware of the extreme peril run by their raiding squadrons when they make such short and hasty excursions.



"VOX CLAMANTIS IN DESERTO."

It is a curious thing that the "Desert," which in old times was associated with man and nature in its most primitive state, should nowadays bear such fruits of advanced civilisation as installations of wireless telegraphy. A recent report from the War Office dealing with the restoration of law and order in the northern area of the district west of Egypt includes the statement that two German wireless sets had been recently discovered hidden in the midst of a desert tract, south of Sollum, and had been brought in as booty by the British reconnoitring forces. The old proverb about *Vox clamantis in deserto* (the voice of one crying in the wilderness) would appear in this instance to have been amply justified.

Throughout the Italian campaign in Tripoli and, we may add, ever since, German strife-stirrers have been exceedingly busy in this region, but the fruits of their activities appear to have been little worth the careful and expensive culture lavished upon them.

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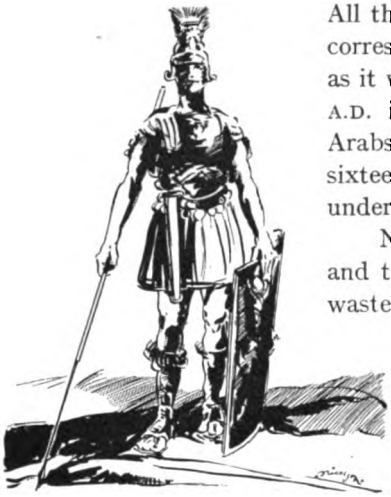

THE ROMAN LEGIONARIES RULED LIBYA SUPERIOR.

All this district was at one time subject to Egypt, and corresponds to the ancient Cyrenaïca, or Libya Superior, as it was called by the Romans. In the seventh century A.D. it was wrenched from Latin domination by the Arabs; it passed into the hands of the Turks in the sixteenth century, and finally, together with Tripoli, fell under Italian rule in 1912.

None but small streams irrigate the countryside and the landscape presents the aspect of an extensive waste of naked rocks and loose sand, interspersed—to the extent of about one-fourth of its area—with wonderfully fertile patches, producing rice, dates, olives, etc., in great abundance. It was in this district that Nuri Bey, brother of Enver Pasha, had for a considerable time been occupying the attention of the British, and Sollum was the scene of the dashing armoured motor-car raid in which the Duke of Westminster so brilliantly distinguished himself on the fourteenth of March last. It will be remembered that on that occasion the whole of the enemy artillery was captured, together with 91 prisoners, crews of vessels shipwrecked on the Cyrenaica coast who had been seized by the Senussi.

These operations were rendered possible by reconnaissance through the means of aeroplanes reporting to General Peyton's force by wireless, and the supreme importance of radio-telegraphy to mobile forces and "flying columns" could hardly have been more graphically illustrated.

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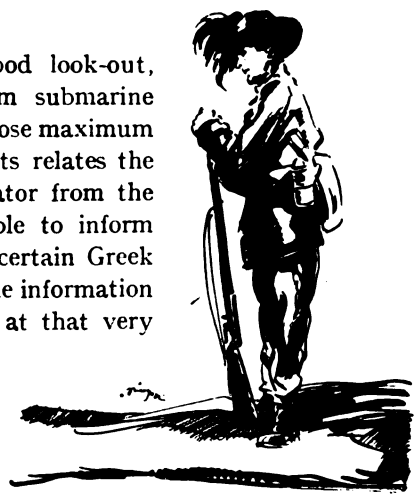
A NARROW ESCAPE.

As a rule, and providing they keep a good look-out, transports are usually comparatively safe from submarine attack, but a correspondent on board a vessel whose maximum speed, even at the best, rarely exceeded 10 knots relates the anxiety felt on board when their wireless operator from the message-waves picked up by his aerials was able to inform them that a submarine had been sighted off a certain Greek island. The perturbation was not lessened by the information given by the officer on watch that the vessel at that very moment was passing the island in question. Here was a case where "ignorance was bliss," for had the submarine sighted the transport nothing could have saved her.

The only resource was to go ahead and trust to luck. This the skipper did, and by good fortune they escaped.



CYRENAICA, WITH TRIPOLI, FELL UNDER ITALIAN RULE IN 1912.

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War Notes

In war time as in peace time anecdotes of all kinds go the round, and it is often extremely difficult to know whether there be any foundation in fact for the original tale or not. As a rule it is safest to place the odds against accuracy as at least 5 to 1. One of our contemporaries, the *Illustrated Sporting and Dramatic News*, reproduced a wireless yarn with the statement that it happened at "Luderitz, and is not a war invention." The scene of action is laid in what was erst German South-West Africa. In the course of the campaign so admirably conducted by General Botha in that arid land the Imperial Light Horse, during a halt, marked out a "field" in the sand for a Rugby football match. Whilst the game was going on a German aeroplane flew over, and appears to have reported the passion for sport evinced by the Britisher to German Headquarters; because, soon after its disappearance, a wireless message came from the enemy jeering at the English for lingering behind to play football instead of coming out into the desert to fight. In the course of the same night, English and German patrols came into contact, and the latter were forced to retire with a loss of two killed and one wounded. The British wireless then replied to the enemy message, saying that they had played the game, and that its result had been "England two goals one try, Germany "nil." If the story isn't true, it ought to be.

Two Good Sporting "Stories."

Our second yarn deals with the great fight between the converted cruiser *Alcantara* and the German raider *Greif*, which figured in our columns last month. After the destruction of the Teuton's wireless and the release of the *Alcantara's* radio apparatus from jamming, other British cruisers quickly appeared upon the scene. One of them, as she arrived, fired a shot over the *Alcantara* which went home upon the already sinking German. On nearing the scene of action, this cruiser, realising that the business had already been done before her arrival, sent a wireless message to the *Alcantara*, which was read before the latter vessel had, in her turn, disappeared; the message ran:—"Sorry—your bird"!

* * * * * *

Rear Admiral Sir Dudley de Chair, who in March last relinquished his command of the 10th Cruiser Squadron to become the F.O. Adviser on enemy trade, recently gave an illuminating interview to the London Correspondent of the *Brooklyn Eagle*. The gallant Admiral paints a vivid picture of the procedure in the case of a typical blockading cruiser. "See her steaming "on her allotted tract of open sea, no lights allowed by night, seaplanes "hovering on the watch by day. At 11 p.m. daily, if our radio-tele-"graphist be not otherwise engaged, he picks up for us the day's war bulletins from "Poldhu, from the Eiffel Tower and from the German long-distance wireless station. "One day a blotch of smoke rises on the horizon: Now, as we are in close touch "wirelessly with our neighbouring units, we know that this can be none of them, "therefore it must be some outsider, perhaps attempting to elude the blockade. We "overhaul her and fire two blank cartridges. She heaves to, and often at sore peril "to life and limb we send an armed guard and boarding party on board."

Daily Routine of a Blockading Cruiser.

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We have so largely been used to connect wireless calls from ships at sea with signals of distress that perhaps some of us may not realise the fact that these calls are even more frequently used to signal escape from danger. Petty Officer J. J. Smith, a Birmingham man attached to the British party serving in Russia under Commander Locker-Lampson, describes in a letter to his wife how they encountered, on their way out such fearful weather that "it was a matter of touch and go whether the vessel would recover or not," and in the course of the night two of their life-boats were carried away by the heavy seas. However, the good ship managed to come safely through the storm, though sorely battered, and their wireless operator was able to radiate the welcome message that the vessel was "O.K."

With the Russian Expeditionary Force.

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A brother officer of Mr. J. J. Smith, serving with the same Russian Expedition, sent home some issues of the periodical published for the amusement and edification of the members of the force. The following extracts from *The Tireless Wireless* will give a very fair idea of the scope of the matter contained therein: "The electric light gave out in a certain part of the ship, and "some confusion ensued, until a cheerful voice floated across the "darkness, 'Never mind if our lights are off, we still have our "Lampson.'"

A Wireless Periodical at Sea.

"We are all nearly up the pole."

"Vim and Vitality.—If you suffer from nerves, debility, or any trouble that makes "life a misery, don't hesitate—try our December sea trips—you won't know "yourself.—Apply *Tossem* S.S. Co."

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In consequence of our vital interests and nearness to the scene of action, the British public keenly realises the full iniquity of our enemy, and is sometimes unjustifiably impatient with our cousins across the water. They have their own difficulties, and contend with them in their own way, and it is fairest for us to "leave it at that." Signs have not been wanting recently that the American patience, which has been wonderfully long-suffering as far as Germany is concerned, is now wearing thin. It is a significant fact that on the date of the reopening of the improved submarine campaign, which is now in full operation, the United States decided to increase the strictness of their wireless regulations. Ever since the start of the war it was officially decreed by Washington that all belligerent ships entering New York Harbour should dismantle their radio-telegraphic installation, and that the latter should remain sealed so long as the vessels remained within territorial waters. These regulations were, in consequence of the fresh submarine campaign, considerably "tightened up," and notices served upon all incomers by a United States destroyer specially detached for the purpose. Moreover, following on the presentation of the latest Wilson "Note," special protection has been arranged for the Arlington, Sayville and other private and national wireless stations, whilst the State Guards at naval yards, munition stores, and other vital spots have been doubled.

Wireless Precautions.

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From an Operator's Notebook

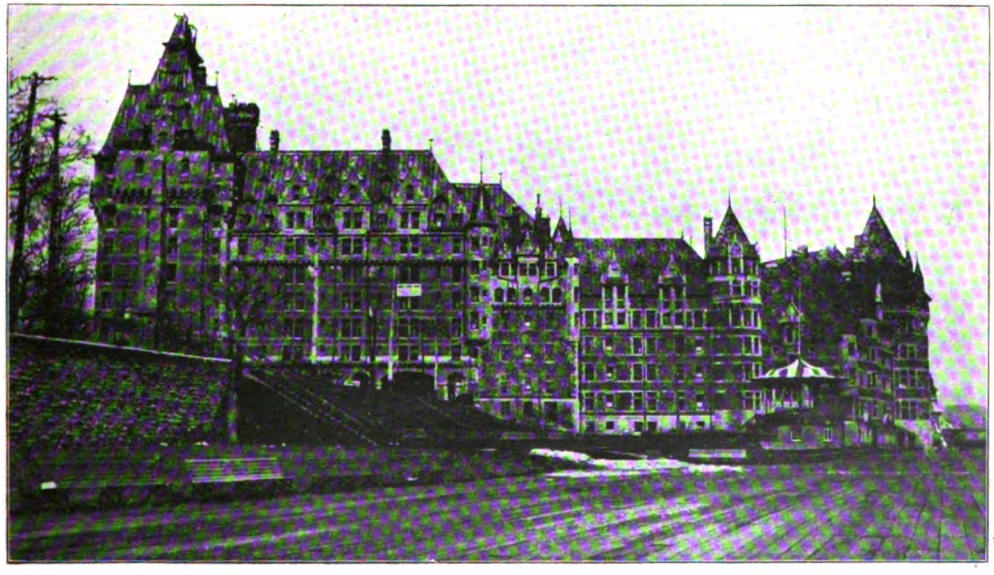
I. A Night in a Wireless Station

By DOUGLAS R. P. COATS

THE reader who knows Quebec, or has seen pictures of the city, must remember the Citadel, perched way up three hundred feet above the River St. Lawrence and overlooking the Chateau Frontenac. The wireless station is situated within the historic walls of the Citadel and nestles in the southern corner beside an obsolete twelve-ton muzzle-loader, dated 1892—a striking reminder of the rapid strides of modern invention.

In mid-winter the climb up the northern slope to the fortress is tedious and often difficult, for the ground is frozen to a glassy hardness. On the cool September night of which I am writing, however, the tufted grass gave good foothold and, although a clock struck eleven before I reached the summit, the fresh Canadian air was invigorating and lent enjoyment to the task. Far below a brilliantly lighted steamer was dropping down the stream bound, perhaps, for England—lucky men aboard her—while a busy little launch puffed shorewards. The riding-lights of many craft dotted the water, blinking in the smoke from an east-bound collier whose throbbing screw told of an empty hold. A siren bellowed in the distance as I finished my climb and descended by some dilapidated steps to the moat.

Admittance to the Citadel was gained by means of a private key through a door



THE CHATEAU FRONTENAC AT QUEBEC. THIS IMPORTANT BUILDING IS SITUATED IMMEDIATELY BELOW THE CITADEL, WHICH LATTER IS OVER 300 FEET ABOVE THE ST. LAWRENCE.

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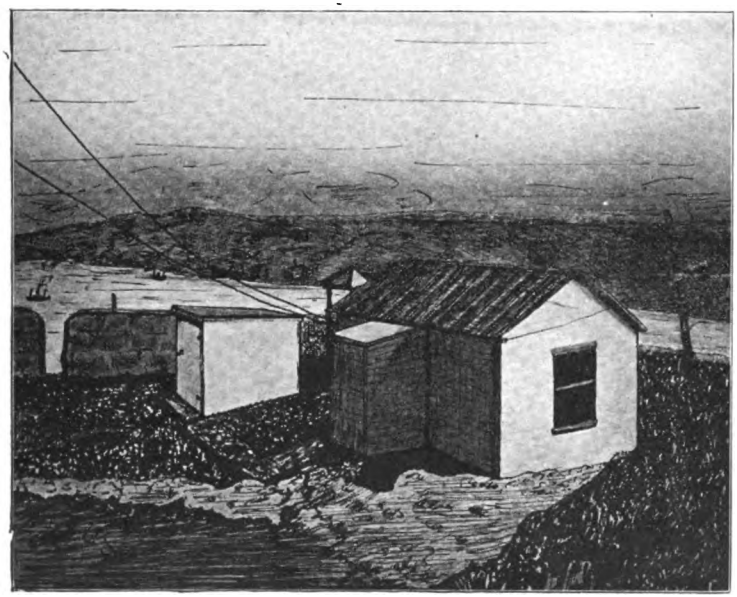
opening on to the parade ground, for entrance by the main gate meant a longer walk, and the man whom I was relieving was no doubt sighing for his bed. Across the square, nearly breaking my shins on the trail of a field gun, and between the stores building and the old French magazine, I picked my way until I saw a light in a window and discerned the dim outline of the cabin.

My brother operator was visibly delighted at my arrival. "Static bad," he observed, "and several ships in the river. Good-night!"—and I found myself alone. The static *was* bad, as the 'phones soon assured me, and, mingling with the "X's", but readable enough, came into my ears the high-pitched note of an American station sending press. He had plenty to say. Over Turkey, Mexico, the suffragettes, and the rest of the world's troubles—insignificant enough as compared with present events!—he wept in long and short musical sobs. He told in tones of shrill satisfaction of the defeat of Vardon, the English golf champion, and became almost nasal—so I imagined—in his rendering of the latest baseball scores. The stock market—dry details concerning Pittsburg Steel and Amalgamated Copper; the New York weather report, and finally "Good-night," dropping down the scale to an almost inaudible "VE." His tale of woe and rejoicing was finished.



A PEN AND INK DRAWING OF THE MARCONI WIRELESS STATION AT QUEBEC.

A low-throated purr called "VCC," meaning Quebec, and informed me that the *Lake Manitoba* was forty miles east. A slight adjustment of the tuner awoke a bedlam of noises of varied pitch; a further adjustment, and one sound increased in volume at the expense of the others, which were lowered to a mere whisper like the shouting of a multitude a long way off. Midland, Ontario, was transmitting to a distant station on the Great Lakes. A variation in tuning brought in the *Lusitania* conversing with Siasconset, and then the *Imperator*, now so dumb, thanks to the British Navy!

Presently the *Teutonic* came into range with a batch of traffic for me, claiming my attention for a while. Then a freighter, happy in the pride of a wireless installation, chirped merrily and announced her position with ostentation and no uncertain spacing, as if to say—"I'm the steamer *So-and-so*, I am, decently owned and right up-to-date, and not one of Kipling's '*little* cargo-boats' either." The telephone rang, and for a few minutes I wrestled with someone whose English was but a shade superior to my French-

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A CORNER OF THE ROOM IN THE QUEBEC WIRELESS STATION.

Canadian patois. I forget what he wanted —the wrong number, anyway, so he shut me off with apologies. A few messages straggled in for the *Teutonic* and one for the freighter, followed, by a lull during which I devoured a chapter of *Gotty and the Guv'nor*—that most delightful tale of a Southend fisherman. A vision of the lower Thames, Westcliff, and all the dear old haunts rose before me as I read, to be rudely shattered by a call from another incoming vessel and forgotten in the handling of "traffic."

A break came at last, however, and I was able to partake of another portion of *Gotty*. Soon the signals from far-distant stations grew weak, and presently most of them ceased altogether. The wireless receiver is most sensitive at night, and now the day was breaking. Through the windo over the operating table I saw the time-ba apparatus silhouetted against a blood-red sky, presenting a grim resemblance to a gibbet. It was impossible to resist the temptation to snatch a peep at the effect of that deep-red herald of sunrise upon the river and city, and I had no cause for regret, for the scene was one of exquisite beauty. The lights of Levis on the opposite shore were not yet extinguished, and shone like gems on a cushion of purple plush. To the south of them, and stretching far back as the eye could see, was an archipelago of hill-tops set in a sea of snow-white mist. Some stars were not yet dimmed: Orion continued his never-ending combat with Taurus the Bull, while I watched where

"The fiery Sirius alters hue,
And bickers into red and emerald."

In the southern heavens the gold of a gibbous moon was fast being transmuted to silver as the day climbed over the eastern hills. It seemed but a moment and the effect was lost, for soon the red sky changed to pink, and then to grey as a ray of yellow sunshine sought out and vanquished each star in turn.

Three Rivers spoiled my meditations, breaking, with all the harshness of a "fixed discharger," into the memory of something finer than all the lithographed Turners I have ever seen, with a well-intentioned "Good-morning!" By and by came the weather report from Montreal, and I knew my duty was drawing to a close. The réveillé sounded somewhere within the Citadel, followed by a footstep scrunching the gravel. The door opened; my watch was ended and my "relief" had come.

TIME BALL POST, QUEBEC.

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Notes of the Month

COMMENCING with its issue of October 1915, we have noticed with interest that the *Revista Maritima Brazileira*, which is published in Rio de Janeiro, has been printing an excellent article entitled " An Historical Resumé of Radio-Telegraphy." It appears to be a chronological survey of the invention right from the earliest times of wireless telegraphy down to the present day.

It is a very excellent plan to recapitulate the steps which have led up to the present day efficiency of the art, and we congratulate our contemporary for its initiative in dealing so thoroughly with a subject upon which the attention of the whole world is riveted.

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An inquest was recently held at Amlwch (Anglesey) Wireless Station concerning the death of John McGrath, retired naval man, who had been engaged as cook at the station. It appears that deceased and a friend were returning home from Amlwch. The night was dark, and the men missed a footpath along which they intended to walk, and fell down a rocky slope as there was no fence of any description. Assistance was procured by the man's comrade, and his lifeless body was removed to the wireless station. The jury returned a verdict of accidental death, and added a rider to the effect that the place should be properly fenced in as a number of people had tumbled down the ravine, which was very dangerous.

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Last month a special Court was held at the Courthouse, Valentia Island, for the purpose of investigating charges of larceny preferred against two persons for " unlawfully and feloniously stealing, taking and carrying away a quantity of lead," made up of four lead containers of a D.P. battery, the property of the Postmaster-General, London, and which was installed at Valentia wireless station. Evidence was brought forward which stated that constables had searched the houses of the culprits, where the stolen goods were discovered. In order to give time for further enquiries to be made the two accused were remanded for eight days.

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An interesting personal touch is recorded in connection with the sinking of H.M.S. *Russell*. Rear-Admiral Fremantle is known universally throughout the Navy as " my son Sydney," that being the way in which his father, Admiral Sir E. Fremantle, was accustomed to refer to him. Rear-Admiral Fremantle was, at the beginning of the war, Director of Signalling at the Admiralty, which included, of course, looking after wireless telegraphy. He served on the North Sea before going to the Mediterranean.

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The decision of the Editor of this Magazine to alter its style with the new volume has, we are pleased to say, been well timed. From the Public and Press alike, we have received words of commendation which are particularly gratifying, in view of the

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difficult circumstances under which the change was made. As an example, we would quote from the *Nautical Magazine* for May. It says: "The new volume of THE WIRELESS WORLD (April issue) has exceeded all our expectations."

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We were all pleased to learn of the rescue of the prisoners whom the Arabs captured on the North-West Egyptian Coast, after the stranding of the s.s. *Tara*. This was accomplished by the Duke of Westminster's armoured car fleet. Last month we published a photograph of these people, who looked none the worse for their experience with the fanatical Senussi.

The ship's officer and the Greek interpreter who were missing among the prisoners have been found and are safe. They went under escort to Tobruk for food, the guard telling the Italian authorities that the prisoners would pay. While food was being procured, the Italians received a wireless message to rescue the prisoners, and the two men were therefore immediately released.

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We have referred in our magazine to the loss of the steamship *Volturno* on October 9th, 1913, which was occasioned by fire in the North Atlantic Ocean. In connection with this disaster, we are pleased to record that the King conferred upon Seaman Samuel Gaskell, of the *Minneapolis*, the Board of Trade Silver Medal for gallantry in saving life at sea. Seaman Gaskell incurred very considerable risk in rendering the service on account of the strong gale and very heavy seas prevailing at the time.

Wireless "Pickles"

OUR contemporary the *Telegraph and Telephone Age* is evidently much perturbed by the appearance of so many youthful wireless experimenters. Under the heading "Knee-Pants Inventors," it writes as follows:—

"The wireless telegraph art has brought into being a new species of engineer (?) "of the 'knee-pants' variety. They might be classed as one of the '57,' but in "whatever category they are placed there is no doubt that many of them make "nuisances of themselves and cause a great deal of trouble and annoyance by their "unbridled enthusiasm and aggressiveness.

"Wireless telegraphy has an unaccountable fascination for the youthful mind, and "school boys, ranging from ten to fifteen years, are its victims. In many cases they are "sons of influential and wealthy parents, who, like most parents, believe their boys are "wonders. These boys get ideas from manufacturers' catalogues and immediately get "busy on something they know nothing about. After some dabbling and crude experi- "menting they hit upon something that is not in the catalogues, and they think they "have made a discovery. Their papas, not knowing any better, try to gain official "recognition of their sons' achievements, and the result is lengthy and time-consuming "correspondence before a quietus can be placed upon the exuberance of youthful spirits."

There is, of course, another side of the shield, and doubtless the writer of the paragraph was "one of the 57" himself when young!

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To Our Readers

THE ancient Romans had a proverb which said, " You settle your " own problems as you go along " (*solvitur ambulando*), and this phrase expresses, in succinct form, that with regard to the question as to whether our readers have appreciated the many innovations in our new volume the best solution is afforded by the experience of our two last issues.

We have had the pleasure of receiving a number of letters and comments, almost all entirely favourable, from various subscribers. One of the most eminent scientists in the radio-telegraphic world summed up his opinion by the statement that our magazine appears to him " to hit a happy medium " between the severely technical review and the popular journal." This pronouncement went " right home," for the " middle course," although it is proverbially the " safest," is always the most difficult of execution. We have a large and highly diverse circle of friends to please, and amongst all the varying tastes and requirements it would be quite impossible for us to " hit the fancy " of each one upon every page.

When, in April, 1911, we first appeared before the reading public under our old title of " The Marconigraph," our issue consisted of 16 pages, and we believe that few of our most enthusiastic supporters ever anticipated that we should be able within five years to bring out an issue more than five times the size, and attaining so high a standard in matter and production. We are the prouder of this fact, in that our latest expansion has occurred at a time when so many of our contemporaries, a large number of whom possessed many excellent features, have been forced by the adverse circumstances brought about by the war to suspend, or disappear altogether.

To co-operation on the part of our readers our magazine owes a great deal of this success and appreciation. As I write, there lies before me upon the editorial table a letter from a correspondent, plainly not written for the purposes of flattery, because it deals with a specific matter which is likely to find attention in our technical pages. Incidentally, our correspondent makes use of the following sentence :

" I shall never have any doubts as to recommending it wherever I go, " and if by letter or article I can help in the least to maintain its high repu- " tation, I shall have great pleasure in so doing."

These few lines seem to strike just the right note, and to afford a hint to many other friends. Here we have a reader who is desirous of helping us to maintain the high standard of interest which we have already reached by offering for our pages paragraphs or articles likely to appeal to other readers. If those of our friends who work or live in various more or less

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remote parts of the world were to give us the benefit of their experiences in the form of articles or paragraphs (especially if the text were accompanied by photographs or illustrations) they would be simultaneously showing their appreciation of our efforts, and placing in our hands materials for many more of those topographical articles which already find place in our pages, and which interest perhaps a larger proportion of our clientèle than any of the matter which we publish.

Our correspondent's eulogium, however, contains yet a further point. What he says, in effect, amounts to the statement that, having enjoyed THE WIRELESS WORLD for some years himself, he is desirous of extending that enjoyment to others. With this object, he is prepared to recommend it wherever he goes, and no magazine reader can better further the interests of his favourite journal than by consistent pursuance of such procedure. No editor can enjoy a more satisfactory form of encouragement than that of continually seeing his circulation undergoing a steady increase from month to month. We may now let our readers into a secret! All sorts of lugubrious prophecies were made at the time when, at the beginning of our new volume, we added substantially to our pages, with the result that we were obliged also to increase our price. These lugubrious prophecies have been falsified by the event. The whole of our April issue was sold out within three days. We printed a larger edition for our May issue, and that (increase included) has followed suit. But—see what the result of success is upon the editorial mind! Because we have already done so well, we are desirous of doing still better. We feel that we have many readers like the one whose letter we took as the "text" of our present remarks. If such readers would put down upon paper a list of friends whom they know to be interested in radio-telegraphy, and ask them, either verbally or by correspondence, whether they have seen some article, paragraph, or illustration in the latest issue of THE WIRELESS WORLD which has arrested their own attention, they will bring our magazine before the notice of a number of future readers. Please remember that the wider the circle by whom we are read, and the larger the number of copies we are justified in printing, the more we are in a position to add fresh features of interest to those we have already offered. In other words, "nothing succeeds like "success."

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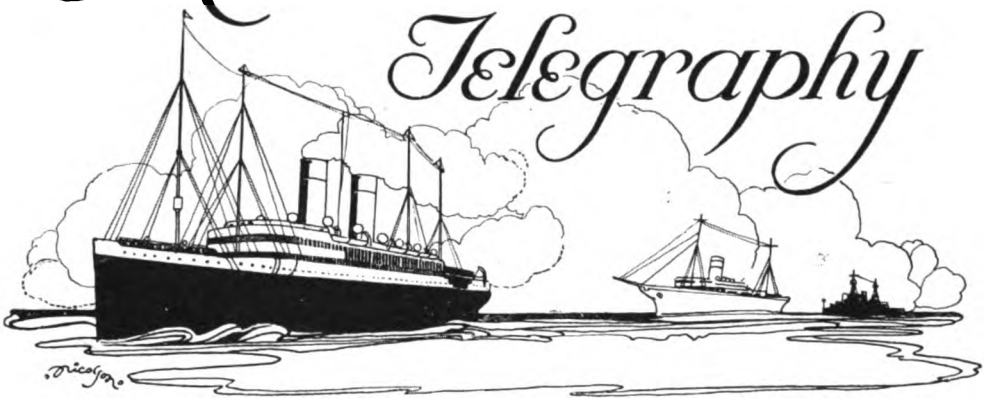
Maritime Wireless Telegraphy



Mutiny on a Liner.

The severe penalty laid down as applicable to persons convicted of wilfully refusing to obey the orders of the captain on board ship fortunately makes mutinies very scarce happenings. A case has just been reported in which wireless telegraphy played a prominent part.

It transpires that a number of union seamen on board the steamer *Mongolia* mutinied when the vessel was off Gravesend Bay, owing to the presence of non-union men on board. Wireless calls for assistance were immediately sent out. These were answered by patrol boats, which, proceeding to the spot, took off 130 union seamen.

This vessel is probably the 13,639-ton liner of the Pacific Mail Steamship Company, New York.

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A Curious Incident.

According to the *Gazette de Hollande* the steamer *Soerakarta*, of 6,926 tons, belonging to the Rotterdam Lloyd Steamship Company and convoyed by the steamer *Kawi*, of 4,871 tons, left Falmouth recently on her homeward voyage to Holland, by way of the North of Scotland route. Two days later when the ships were between the Irish coast and the Shetland Islands, the wireless apparatus on the *Soerakarta*, which was in constant use between the two ships, suddenly stopped, after she had wirelessed that she had been summoned by a submarine to lower a boat and show her papers. The *Kawi* at once returned to the *Soerakarta* and saw at her port side a submarine, without any indication as to her nationality.

Suddenly a shot was fired, and the four people who had emerged from her disappeared in the water. A second shot finished the submarine. Both shots were fired by a British trawler which had appeared on the port side of the *Kawi*; the second shot hit the submarine amidships.

The whole affair took place within about ten minutes. The British vessel enquired whether any help was needed, and whether anyone was wounded in the Dutch boats, which had been very near the fire. The answer being in the negative, she disappeared

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after having stated that the submarine was German and of the latest type with a crew of sixty, and that the British had been lying in wait for her for four days.

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A NOTABLE BRITISH SAILER.

Our readers will no doubt be surprised to learn that the White Star Line's steamship *Mersey* has been sold to Norwegian owners and renamed *Transatlantic*. She will continue to act as a training ship, but will carry cargo. It will be remembered that the White Star Line fitted her with electric light throughout and equipped her with wireless preparatory to her employment as a training ship for cadets destined to hold positions in the White Star Company's fleet.

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FRENCH LINER ATTACKED.

The utility of wireless intercommunication between ships at sea has just been recently interestingly and happily exemplified in the case of a French liner, the *Colbert*, which was attacked and fired at without warning by an enemy submarine. She not only succeeded in herself escaping by putting on full steam, but the wireless warnings which she was able simultaneously to radiate from her aerials were picked up by another liner, which was running straight into the lion's mouth ! As a result the latter changed her course and succeeded in eluding the attention of the enemy.

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THE SINKING OF THE "PRINCIPE DE ASTURIAS."

The Argentine Press has published ample details of the horrible catastrophe which caused the loss of 100 lives of persons who were travelling on board the luxurious Transatlantic liner *Principe de Asturias*, which sank off the Brazilian coast.

From private information supplied by survivors themselves we may state that the radio-telegraphists who were on board did everything possible to work their wireless apparatus in order to call for help. They could only send two or three SOS signals without giving their position.

Moreover, this call, even if it had been complete, would have been almost useless, as the Santos and Rio de Janeiro stations only have limited hours of service and the Island of San Sebastian could not hear them as the wireless operator there had died on that day.

In our opinion, coastal stations, if they are to be effective, should have a continuous service in view of the fact that accidents happen at sea by night as well as by day.

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INDIAN LINER STRIKES A MINE.

On her last homeward voyage to Amsterdam, the Royal West Indian Mail Line steamer *Columbia* sent a wireless message that she was in a sinking condition off the New Galloper Lightship in the North Sea, and asked for help. Before arrangements had been completed for sending the assistance required, another wireless message was received announcing that aid was no longer wanted.

The vessel subsequently arrived under her own steam at Gravesend, where she was examined. From the damage revealed, it is believed that the vessel struck a mine.

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The forecastle and forehold were full of water, but fortunately no casualties were reported.

The *Columbia* was on her way from Baltimore to Amsterdam with 4,300 tons of maize for the Dutch Government.

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MINE SWEEPERS SUMMONED BY WIRELESS.

While the Dutch steamer *Maashaven* was being towed by two tugs near the Galloper buoy the look-out saw the Dutch steamer *Dubhe* strike a mine. Curiously enough the tug which went to her assistance also struck a mine and sank in four minutes. Meanwhile the *Maashaven* herself ran on one of these engines of destruction, but fortunately kept afloat. A British trawler appeared and at once requisitioned aid by wireless from four British mine sweepers. These assisted the *Maashaven* and *Dubhe* to the British coast.

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EXCEPTIONAL WIRELESS DISTANCE.

The Oceanic Company's steamer *Sonoma*, which recently arrived at Sydney from San Francisco, was not out of touch with land from the time she cleared the Golden Gate until she entered Sydney Heads. All the time the vessel obtained news of the war and other important world events from the American side, no news being available from any of the stations in Australia or Fiji. At a distance of 4,700 miles she was kept informed, while the receipt of news at 2,300 miles was quite an ordinary performance. This is very creditable, as the distance between the two ports is about 7,000 miles.

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SS. "DUENDES" ATTACKED.

The following report has been made by the master of the ss. *Duendes*, which was attacked by gunfire without warning by a German submarine. The master of the vessel, Captain Alban Chittenden, by his judgment, pluck and skill, succeeded in saving the ship from destruction, although hit by shell nine times.

"On Saturday, March 25th, at 5 p.m., we observed a Scandinavian barque lying hove to, distant about five miles, under two lower topsails with the main topsail to the mast.

"In consultation with the chief officer, John Blacklock, we thought it very strange, and fearing that a submarine might be lying on the other side of her, we kept a good look out, keeping away two points from the barque. Our course was North 83 East true, speed 10.5 knots.

"At 5.40 p.m. we heard a shot, which dropped about four ship's lengths astern of us. We then sighted a submarine, which opened fire on the starboard quarter at a distance of about three miles. We immediately altered the helm so as to bring the submarine right aft, and sent to the engine-room to put all hands on to the fires and open the ship out to the utmost. At the same time I instructed the Marconi operator to send out the SOS. signal, giving the position of the ship, etc., which he did; the same was immediately picked up by a shore station, after which the Marconi operator sent out all positions as the course of the ship was changed.

"The submarine continued firing from the port and starboard quarters until

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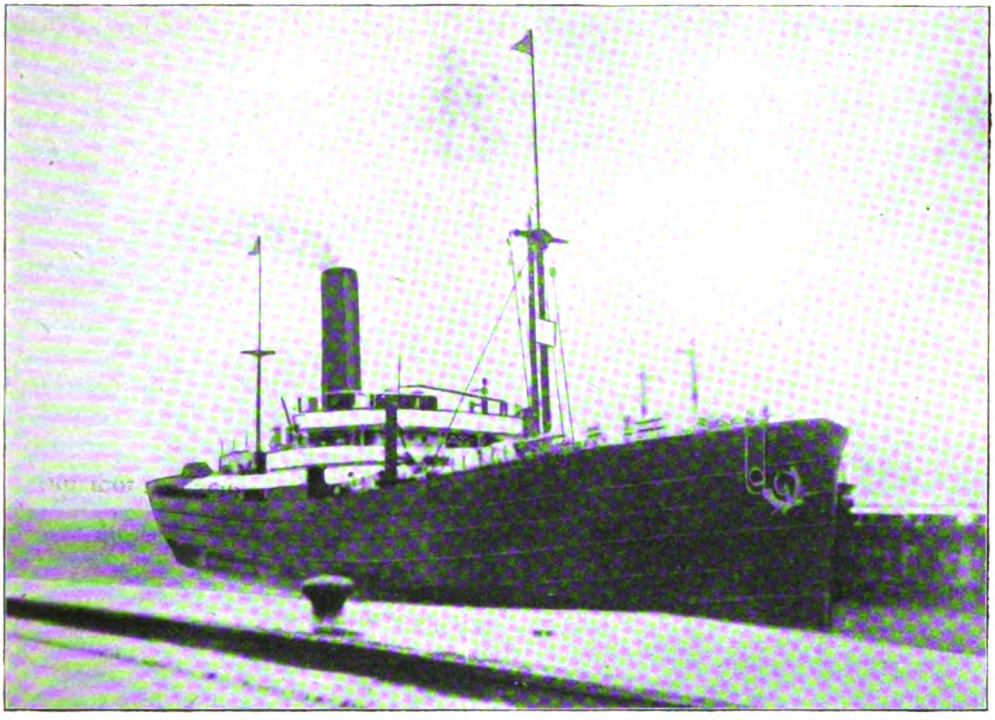

SS. "DUENDES," OF WHOSE ESCAPE FROM A SUBMARINE A STORY IS TOLD IN THESE PAGES.

6.30 p.m., working us round to the north-east and north in order to keep us in the remaining light in the sky.

"As the firing in the stokehole became greater and the speed of the ship increased, flames came out of the funnel, which made a valuable target for the submarine, consequently we were forced to put the dampers on.

"The firing ceased from 6.30 to 6.45 p.m., when he commenced again, the shots falling ahead of the ship on both sides. He continued firing until 7.25 p.m., then ceased for ten minutes owing to the weather becoming squally. At 7.35 p.m., the squall clearing, he opened fire on us with shrapnel, working us right round as before to the remaining light in the sky. We kept altering the course to keep the ship out of the light and to bring the sea abeam, which made it very difficult for him to aim accurately.

"One of the shrapnel shells put the wireless apparatus out of order for a time, some of the shots entering the Marconi cabin and bridge deck house. The firing ceased at 8 p.m.

"The deck was strewn with shrapnel, and the ship has been hit in several places with small pieces, but as far as we are at present aware no serious damage has been done, with the exception that two of the plates on the starboard side have been knocked in rather badly with some of the first shots.

"The behaviour of all on board was admirable."

(The *Duendes* is a steel screw steamer of 4,602 gross and 2,948 net tons, built at Sunderland in 1906 by Sir James Laing & Sons, Ltd., and owned by the Pacific Steam

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Navigation Company. Captain Alban Chittenden entered the service of the Pacific Steam Navigation Company in 1894, and was appointed to the command of the *Duendes* in 1912.)

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H.M.S. "RUSSELL" LOST AT THE END OF APRIL LAST.

At the end of April last the Admiralty announced that H.M.S. *Russell*, flying the flag of Rear-Admiral Fremantle, had struck a mine in the Mediterranean and sank. Unfortunately about 120 officers and men are missing. H.M.S. *Russell* was a battleship of the *Duncan* class, laid down in 1901 and completed in 1903. She possessed a displacement of 14,000 tons, and her prime cost was £1,037,995. Her main armament consisted of four 12-inch guns, twelve 6-inch guns, twelve 12-pounders and four torpedo tubes, together with the sister vessels of her class. She was fitted with wireless telegraphic apparatus. It is interesting to recall here that H.M.S. *Montague*, which was wrecked on Lundy Island in 1906, was a sister ship to H.M.S. *Russell*.

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JAPANESE STEAMER ON THE ROCKS.

According to a dispatch from Hong Kong, the captain of the Japanese steamer *Chiyo Marun* wirelessed that there was a heavy south-easterly sea, and his vessel was slipping on to the rocks. Subsequent news was received to the effect that she had been abandoned. Early next morning a British destroyer, which was standing by, sent a wireless telegram that the position of the ship had changed. She would not reply to the destroyer's messages, either by lamp or wireless. It was therefore presumed that the crew who had remained on the vessel had landed. A Japanese cruiser went to the assistance of the stranded vessel, and relieved the few members of the crew who still remained aboard.

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NORWEGIAN STEAMER WRECKED.

Whilst on a voyage in the South Atlantic the Spanish steamer *Leon XIII.* picked up a boatload of nine people, members of the crew of the Norwegian steamer *Marika*, which had been wrecked. The captain of the *Leon XIII.* immediately sent a wireless message to Monte Video reporting the incident. The Marika was on a voyage from Buenos Ayres to Copenhagen.

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UNARMED SHIP SHELLED.

Referring to the attack made recently on the London steamer *Ashburton*, which was sunk by a German submarine, it transpires that she was unable to send a call for help owing to the fact that her wireless equipment was shot away. Unfortunately five of the crew were injured by shrapnel. The *Ashburton* was a vessel of 4,445 tons, and owned by the Australian Steamship Company.

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A NEW ITALIAN LINER.

We are able through the courtesy of the London Office of the Italian State Railways to publish a photograph of the new steamer *Duilio* belonging to the Navigazione Generale Italiana, which is to inaugurate the new quick service between Europe and South America.

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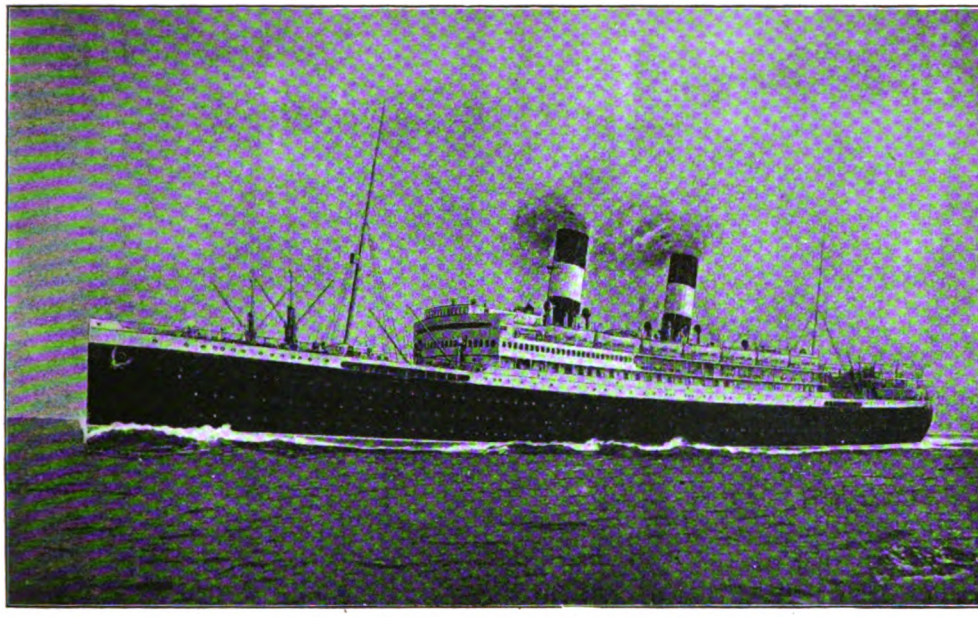

SS. "DUILIO," THE NEW PASSENGER STEAMER
OF THE NAVIGAZIONE GENERALE ITALIANA.

She is the largest and best appointed liner plying between Europe and South America. Her displacement is 27,000 tons, length 660 feet, breadth 78¾ feet, depth 124½ feet, and registered tonnage 22,000. She was built by Messrs. Ansaldo & Co., of Genoa, and has eight decks. The propelling machinery is on the quadruple turbine screw system, and her designed speed is 20 knots. The safety of passengers and crew has been amply provided for, the ship being partitioned into 17 watertight compartments. A double bottom runs the whole length of the vessel, and the lifeboats, including motor boats, will accommodate 3,000 persons. Special submarine apparatus has been fitted to give warning of the proximity of rocks, icebergs and other dangers, and a high-power wireless system is fitted. From the point of view of comfort, she will be one of the most luxurious steamers at present sailing the high seas.

* * * * * *

Relief Ship Beached.

According to a telegram from the North Foreland Wireless Station, the following wireless message was received from the Dutch steamer *Batavier IV.*: "Swedish steamer *Fridland*, Belgian relief vessel, sinking. Steamer *Rio Branco* has been sunk." Later the same evening another message was transmitted, reading: "We are near Longsand Lightship with the steamer *Fridland*; will bring her into Black Deep."

From Southend the next day came a telegram to the effect that the *Fridland* had been beached on the Blyth Sand at the mouth of the Thames.

The *Fridland* is a steamer of 4,960 tons, built in 1910, and registered at Gothenburg. In the early part of the war she was captured and taken to Kirkwall for examination. The *Rio Branco* referred to in the first message was a Brazilian steamer of 2,258 tons, registered at Rio Janeiro. It is surmised that both these vessels struck mines.

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THE TRUE ORIGINATORS OF THE MORSE CODE.

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Correspondence

To the Editor of THE WIRELESS WORLD.

SIR,—I read with interest your article in this month's issue of THE WIRELESS WORLD *re* gramophone records as a means of instruction for students in the Morse code, and I note you pay a glowing tribute to the numerous amateurs who have found the experience gained in the pursuit of their hobby useful to them in the service of their country. This, however, is quite contrary to my own experience. Prior to the war I was a keen amateur, and flatter myself that my station was well equipped and efficient, and every portion of the installation was made entirely by myself. I continued the study after my station was dismantled, and have since obtained the P.M.G. first-class certificate. I have also been studying the various systems employed, and have neglected no opportunity of adding to my knowledge of the subject. I naturally thought that my knowledge would be of some little use in some sphere or other at the present time, and made several enquiries, but only to receive the " cold shoulder " at every attempt.

The mercantile marine will not have me as I am of military age, and yet I am *too old* for the Navy. I have not tried the Army, as several of my fellow-students tell me that when they applied recently there were no vacancies. I am just turned thirty-three, and am married, and a partner in an old-established business, which it would be a considerable sacrifice to leave, even for the period of the war, so can anyone blame me if I object to joining the Army as an ordinary infantryman, and spending several months in a training camp learning to form fours, etc., when by several years of self-study and a considerable amount of expense I have qualified to fill a technical position, of which there *must* be some need. (Signed) G. R. LEWIS.

To the Editor of THE WIRELESS WORLD.

SIR,—With reference to the article on " The Action of Crystal Detectors," the author appears to have completely neglected the effects of a boosting voltage. This might cause some modification in his arguments, since in the case of a valve there is, in the majority of instances, a certain amount of steady current flowing through the telephone circuit (even in the entire absence of a " boosting battery " in the usual sense) due to the stream of electrons shot off from the hot filament. It would seem only fair in comparisons to specify the same conditions in both cases—say, for example, with boosting voltage to obtain the greatest sensitiveness in all cases.

If the author has not already seen it, may I be permitted to draw his attention to a paper by Mr. D. Owen, read before the Physical Society a few weeks ago, in which very good agreement is shown to be obtained between measured rectified current from a crystal contact, and that calculated on a simple themo-electric theory ?

His statement that " there are several detectors on the market which utilise much more of the wave than a valve can possibly do, and yet none of them is as sensitive " scarcely seems quite accurate when considering, say, the " audion " type of detector in which the oscillatory P.D. is applied to the " grid " electrode and the telephone circuit is connected from the plate to the filament ; as in this case, *both* positive and negative voltage loops may be effective in modifying the telephone current, so that " more of the ware " is utilised than in the case of a simple rectifier. Such detectors, as a rule, are more sensitive than the simple valves. (Signed) PHILIP R. COURSEY.

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The Methods Employed for the Wireless Communication of Speech (iii)

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institution of Electrical Engineers, on February 2nd, 1916.)

Short Spark Methods of Generating Oscillations.

The apparatus placed in this group is generally classed as producing trains of damped oscillations, which follow one another with great rapidity so that the group frequency is above the acoustic limit. This, as pointed out above, is not necessarily the case, and hence some writers often refer to them under the heading of "Arcs," so that it will be convenient to consider them here after having briefly reviewed the principal forms of arc generator. The question as to whether a given discharge is an arc or a spark is often rather a difficult one to decide, as the distinction between the two is not by any means a ways apparent to the eye even if the discharge is visible. The distinction between the two is more a matter of convention than of real difference in many cases, since one form of discharge readi y merges into the other with little apparent change in its characteristics.

In the ordinary meanings of the terms, a spark is a definite disruptive breakdown of the dielectric between the two terminals by reason of the electric stress applied to the medium being greater than the critical breakdown value. The current which passes across the dielectric under these conditions is only momentary, and is carried by a few ions which generally arise from the material of the dielectric. An arc, on the other hand, is a sustained discharge through the dielectric, which therefore requires the provision of a plentiful supply of ions to form carriers for the current. In the majority of cases these ions are produced from the material of the electrodes, and often arise through chemical dissociation by reason of the heat generated.

If an arc discharge goes out the source of ionisation ceases as soon as the electrodes cool down again, so that if the electrodes are fixed it is necessary that the dielectric should be punctured by a spark before an arc discharge can be restarted between them, unless some exterior source of ionisation is provided. Hence, it is evident that an arc discharge cannot be maintained if a sufficient supply of ions is not available. If the electrodes are kept cool, or made of a material which does not readily yield ions, it will be difficult to start or maintain an arc discharge between them, and hence if a discharge take place at all between such electrodes it will tend to remain in the spark form, so that once a discharge has passed it cannot continue more than a very short space of time on account of the lack of ions to form the conducting path. Therefore it follows that a discharge gap of this form will be of the "quenched" variety —meaning that the discharge is quenched or extinguished very rapidly. Further, if the discharge is quenched out very rapidly it follows that the gap should be ready for

Erratum.—On p. 95 of the May issue, *read* $n = \frac{1}{2\pi\sqrt{CL}}$ *instead of* $n = \frac{1}{2\pi}\sqrt{CL}$.

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the passage of a fresh discharge a very short space of time after the first has passed, and hence this type of gap satisfies the requirements of being able to produce a series of discharges following one another very rapidly; in other words, it should be suitable for the purposes of wireless telephony.

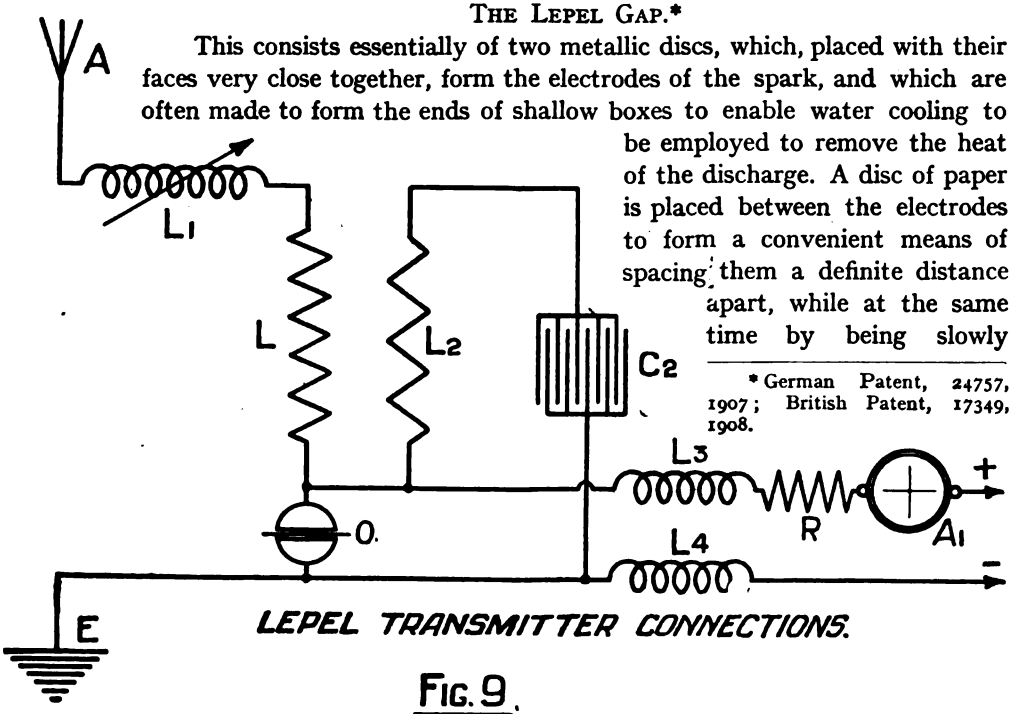
Spark-gaps of this kind form the basis of the Lepel, Telefunken, Peukert and other patents, and are based on the results of experiments of M. Wien on the quenching effect of short spark-gaps.

Of these gaps the Telefunken is most commonly used in practice with alternating current (of frequency about 500 per sec.) for the purposes of spark wireless telegraphy so as to obtain a good musical note. The Lepel gap is most commonly used on direct current, and under such conditions the spark frequency may be made very high, and is generally sufficiently so for use in wireless telephony.

Any of the forms of quenched gaps will yield a high spark frequency if connected to a suitable direct current source, and the electrical constants of the circuits are properly adjusted. The most important adjustments in this respect are those of the choking inductances in the main supply circuit, and also the value of the condenser in the oscillation circuit, since this capacity combined with the capacity between the plates of the oscillator itself, in conjunction with the choking inductance and series resistance, determines the "time-constant" of the charging circuit (charging the condenser between each spark), and hence also the spark frequency. That is to say, an increase in the choking inductance or in the series resistance will increase the charging time, and therefore lower the spark frequency, while a decrease in the capacity of the oscillation circuit condenser or of the capacity of the oscillator will raise the spark frequency.

THE LEPEL GAP.*

This consists essentially of two metallic discs, which, placed with their faces very close together, form the electrodes of the spark, and which are often made to form the ends of shallow boxes to enable water cooling to be employed to remove the heat of the discharge. A disc of paper is placed between the electrodes to form a convenient means of spacing them a definite distance apart, while at the same time by being slowly



LEPEL TRANSMITTER CONNECTIONS.

FIG. 9.

* German Patent, 24757, 1907; British Patent, 17349, 1908.

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burnt away it furnishes a hydrocarbon atmosphere in the discharge gap, which improves its operation.

The thickness of paper most commonly employed is from 5 to 10 mils. (0·005 inch to 0·01 inch), but, of course, varies somewhat with the supply voltage. The latter is generally about 400 to 500 volts D.C.

When in operation the gap should be connected in series with suitable choking inductances and resistances to limit the flow of current from the supply mains, and also to determine and regulate the spark frequency. The oscillation circuit is connected in shunt across the gap in the usual manner. Usual diameter of discs = 3 inch to 5 inch.

A spark frequency of the order of 10,000 per sec. or more can usually be obtained.

The discharge that takes place in the gap is often described as an arc rather than as a spark, and the improvement that is stated to result from the hydrocarbon atmosphere, resulting from the decomposition of the paper ring separating the electrodes, perhaps lends support to this view. It is probable that the discharge really partakes of the nature of both the spark and the arc, and is intermediate between the two types.

THE TELEFUNKEN SPARK-GAP.*

This spark-gap is very similar to that of von Lepel, just described, and operates in the same manner. The chief points of difference in the most usual constructions are the use of mica ring separators between the copper disc electrodes instead of the paper employed in the Lepel gap; and the use of a number of gaps in series in place of the usual one, or at most two, in the Lepel arrangement. This means that higher voltages must be employed, with consequently a great power output. Air cooling of the discs is also generally resorted to instead of water cooling.

The Peukert Oscillation Generator is similar to either of the above with the exception that oil is employed as the dielectric, and it is kept in circulation by the rotation of one of the discs. This dispenses with water cooling.† The discs are usually spaced about 1/250 inch apart. Direct current at 500 to 600 volts is employed. The discs are silver-plated copper.

A somewhat similar arrangement to the Telefunken gap has been employed by Ditcham in some recent experiments. Successful telephonic communication has been carried on by their use for distances up to about 100 miles.

A number of spark-gaps are used in series on a supply voltage, direct current of from 1,000 to 2,000 volts. (See *The Electrician*, Vol. 72, p. 569.)

Recent experiments with oscillations produced in this manner by means of short-quenched spark oscillation generators have shown that they may probably prove to be of considerable value for the generation of oscillations suitable for the uses of wireless telephony.

By investigation of the oscillations produced by the spark-gap, by means of a Braun cathode ray tube, it has been shown that under certain conditions a short spark-gap between brass and aluminium or other metallic electrodes placed in an atmosphere of coal gas, and supplied with direct current at about 400 volts through suitable choking

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* German Patents, 27164, 1908; 27483, 1908; 28198, 1908; also British Patent, 6424, 1909.

† See *The Electrician*, Vol. 64, p. 550, 1910; see also J. A. Fleming and G. B. Dyke, *Proc. Phys. Soc. Lond.*, 23, p. 117, for description of similar spark-gap.

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inductances and resistances, is capable of yielding practically undamped oscillations; this means that the spark frequency must synchronise with the oscillation frequency, so that impulses are supplied to the oscillation circuit exactly in phase with the oscillations at periods which cannot be further apart than about two or four half-waves of the oscillation current, so that the amplitude of the oscillations is maintained practically constant. It may perhaps be emphasized in this connection the excellent manner in which the phenomena which takes place in such oscillation circuits may be shown up and studied by means of the Braun cathode ray tube, previously mentioned. The effect of varying the capacity in the circuits or the choking inductance, etc., may be investigated very easily, and the best effects obtained by proper adjustments. Some interesting experiments on this subject have recently been carried out by H. Yagi on the production of undamped oscillations from an aluminium-brass spark-gap.*

The Marconi Disc Discharger for Generating Undamped Waves.

Another form of spark discharger by means of which it is possible to generate undamped waves is the Marconi multi-disc discharger.† The arrangement of apparatus is very much that of the usual Marconi studded disc discharger fed from direct current.

In this instance, however, the spark frequency is arranged to be much higher than the usual, and at the same time a number of such discs are arranged on the same shaft, with their studs or contacts so displaced relatively to one another that the sparks will occur on successive discs at regular intervals during the spaces on the first disc. Each disc is preferably arranged to discharge through its own condenser and oscillation circuit, independent of the others, the effects of them all being summed up in a secondary circuit connected to the aerial in the usual manner.

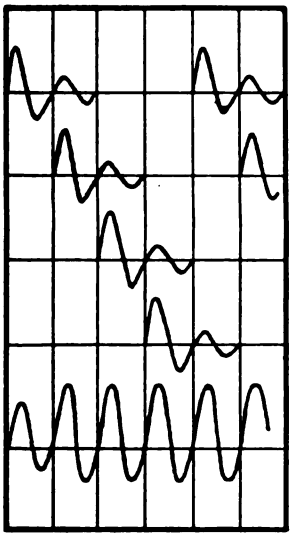

Diagram of mode of operation of Marconi Multi-Disc Discharger.

Fig. 10.

If now we so arrange the oscillation frequency of each circuit that one complete wave (or at the most two) of current takes place in the interval between the spark on one disc and the next spark on the next disc, the effect of the second spark will reinforce that due to the first, and the oscillations will be maintained.

If the sparks take place every complete wave the oscillations will be to all intents and purposes undamped; but if every second wave, there will be a slight diminution of amplitude every alternate wave—much as may probably be the case

* H. Yagi, *The Electrician*, 76, p. 195, Nov., 1915.

† Wireless World, 2, p. 75, 1914.

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with some of the short spark dischargers, described above. Such an arrangement should be capable of dealing with considerable power if properly designed, while the oscillations produced would be eminently suited for wireless telephony. The system, in fact, amounts to an attempt to accomplish in a regular mechanical manner what happens in effect in some of the short quenched spark dischargers—*i.e.*, to ensure that each fresh impulse due to the passage of a spark shall exactly synchronise with the existing oscillations in the circuit. To a considerable extent this occurs automatically in the short spark methods by reasons of the reactions which take place between the currents in the various circuits; but, nevertheless, some irregularities will generally occur. The great objection to the mechanical method, apart from the difficulties of the high speeds required for the discs, is the difficulty of maintaining the discs running at a perfectly definite and constant speed. This is essential if the method is to work properly in order that the successive impulses shall synchronise properly with one another. It renders imperative some very sensitive form of speed governor that will maintain the discs running at a constant speed.

VACUUM OSCILLATION GENERATORS.

In 1884 Edison showed that an incandescent filament of carbon (such as a lamp filament) possesses the property of ionising the surrounding air, so that it becomes a unilateral conductor.*

This property has been turned to practical utility by Dr. Fleming and others, and forms the basis of the well-known Fleming oscillation valves which are now often used as wireless detectors. Some of these values have characteristics (*i.e.*, volt-ampere curves) which at some point are negative, like an arc characteristic, and hence it is possible to use such valves as generators of oscillations just as the arcs can be so used.

The use of a third, or "grid" electrode, as it is generally called, as in the de Forest "Audion" and others, leads to considerable advantage from the point of view of their operation as oscillation generators.

The mode of operation of this type of apparatus may be briefly summarised as follows: The hot filament has the property of emitting negative electrons, and hence the combination of hot filament and cold plate in an exhausted vessel forms an electrical conductor, which will allow current to flow in one direction only—that is to say, it is a unilateral conductor, and therefore will exert a rectifying action on an alternating P.D. applied to it. Since the current passing through this vacuous space is carried by a stream of moving electrons, and since an electron is merely a negative electric charge, it is evident that the motion of the electrons can be influenced either by an electro-static or by a magnetic field, and therefore the strength of the current flowing between the filament and the plate can be varied by subjecting the electron stream to electric or magnetic fields arranged so as to deflect the stream off, or partially off, the plate.

As shown in Appendix 2, for the conditions usually met with in oscillation valves the electric deflection will produce greater effects than the magnetic. Hence its use in practice for this purpose. If it is desired to influence the electron stream by an electric field, the point to which the deflecting potential is applied should obviously be placed as close to the electron stream as possible. Hence the "grid" electrode in the "audion" type valve is placed right in the path of the

* See J. A. Fleming, *Proc. Royal Institution*, 1890.

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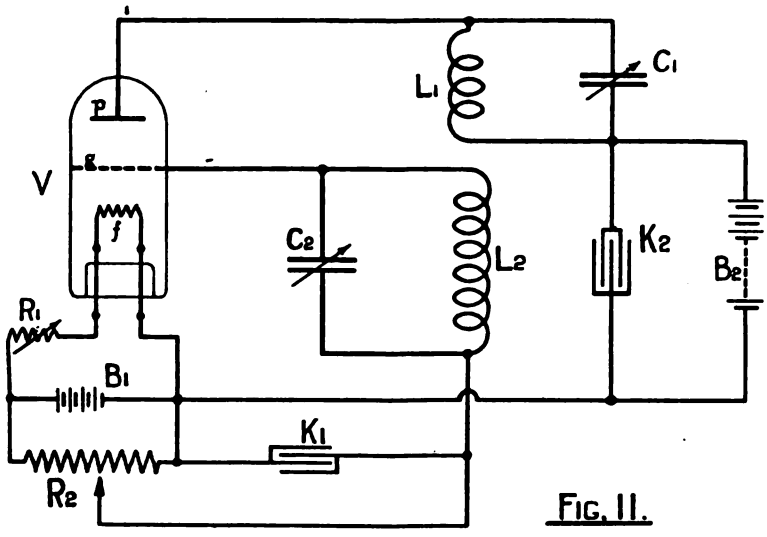

FIG. 11.

electrons between the filament and the plate, so that a small P.D. applied between this grid and the filament will cause large variations in the current flowing to the plate. The Marconi Co. have, however, shown* that it is possible to have the third electrode of the valve outside the glass bulb instead of inside, so that this should lead to a simplification of the construction. In general, however, this method of construction is not so effective as when the "grid" is placed inside the valve, and in the path of the electrons between the filament and the plate. This renders it possible to use this type of valve as an amplifier and consequently as an oscillation generator, for if we apply a small oscillatory P.D. to the grid circuit the above action of the valve as an amplifier will result in a magnified oscillation in the plate circuit. By arranging this magnified oscillation, to be further magnified by repeatedly passing through the amplifier, its amplitude will be continually increased until a steady state is reached. In this manner fairly powerful oscillations may be set up which may serve for use in wireless telephone transmission.

They possess the great advantages of simplicity and of reliability of operation; but since the forms at present constructed are only capable of handling relatively small powers, it is necessary to utilise a considerable number of them in parallel in order to obtain sufficient energy.

In fact, in the most recent long-distance tests with this method as many as from 300 to 500 of such oscillation valves, or "audions," were used in parallel. Successful speech was obtained across the Atlantic from Arlington, Va. (U.S.A.), to the Eiffel Tower, and also from Arlington to Honolulu, a distance of 5,000 miles.

A difficulty that arises when attempting to construct larger models of these valves to handle heavier oscillatory currents is the rapid disintegration of the hot filament by the ions, etc., shot off from it, and by the extra heating that is caused by the large oscillatory currents passing through it, and through the vacuous space. The electronic bombardment of the grid and plate may also give rise to considerable heating unless means are provided for keeping them cool.

The Marconi Co. claim in some recent patents† to have overcome this difficulty to a very great extent by the use of a platinum tube inside the valve, the tube being heated by internal carbon filaments, thus avoiding the sealing in of very large con-

* Marconi Co., British Patent, 13247, 1914.

† See, for example, British Patent, 6476, 1915.

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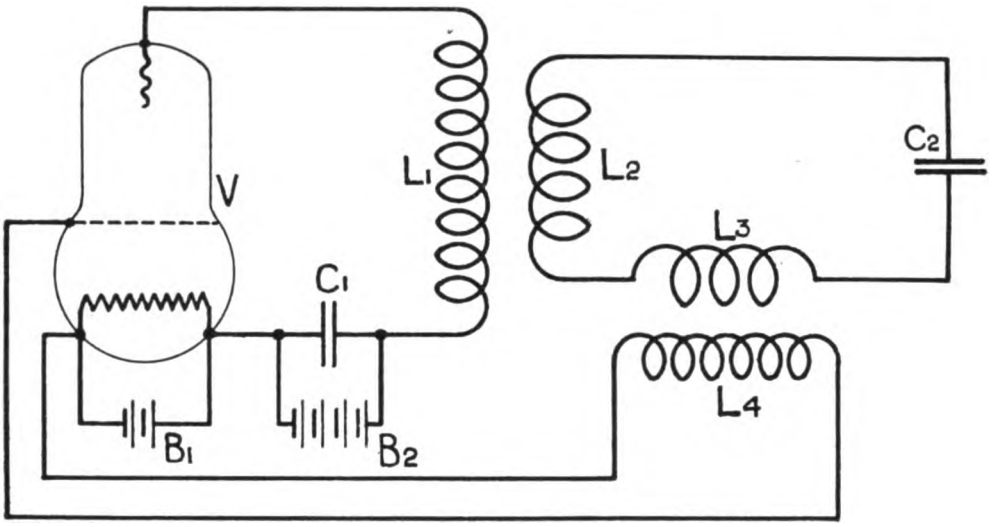

FIG. 12.

ductors to heat the large mass of platinum inside the valve, while at the same time the large surface of the platinum tube prevents its rapid disintegration.

The use of a coating of lime on the incandescent filament has been shown, by Wenelt* and others, to yield a much greater conductivity of the vacuous space; that is, the heated lime promotes the emission of a copious supply of electrons from the cathode, or heated electrode. R. S. Willows† and others have described some interesting experiments which bring out the advantages to be obtained from its use, and also from the use of heated aluminium phosphate on the anode (which substance J. J. Thomson has shown emits positive ions when it is heated). It might, therefore, be expected that the use of these substances in the vacuum oscillation generators would lead to greatly improved operation of the same, but very little work seems to have been done in this direction. A serious disadvantage, however, appears to be loss of vacuum due to emission of gas.

O. Tugman‡ has investigated the effects of gas pressure and electrode spacing on the operation of these vacuum valves and has arrived at some valuable conclusions which should also be applicable to the cases we are considering, viz.—of oscillation generators.

Within the last year the results of a considerable amount of experimenting in this direction have been published in America by Langmuir§ and Dushman‖, and it has been found that greatly improved results may be obtained by using very much higher vacua—so much so that the name of "kenotron" (from the Greek κενος, an empty space) has been given to the oscillation rectifiers that they have constructed. They have used the name "pliotron" (Greek πλειον "more") to designate the oscillation amplifiers having the third or "grid" electrode. These may also be used as oscillation generators. These generators are apparently capable of handling consider-

* *Annalen d. Physik*, 14, p. 425. † *The Electrician*, 68, p. 302. ‡ *Physical Review*, 29, p. 154.
§ I. Langmuir, *Proc. Inst. Radio Engineers*, April, 1915.
‖ S. Dushman, *The General Electric Review*, May, 1915.

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able powers owing to the fact that the high vacuum enables much higher voltages than the usual to be employed.

For this purpose they have suggested a combination of the two types of valves—viz., one a high voltage rectifier (kenotron), to rectify a high voltage A.C. supply which may then be used to supply a high voltage direct current to the pliotron oscillation generator. The initial high voltage is most easily obtained by this arrangement from a step-up transformer run off an ordinary A.C. supply circuit. This method apparently represents a considerable advance on previous apparatus of this kind.

As mentioned above, all apparatus of this class possesses great advantages over the arc and similar methods of oscillation generation, on account mainly of the relative simplicity of the apparatus and of the ease and reliability of its operation, coupled with the fact that practically no attention or adjustment is required beyond the initial switching on. The large range of frequencies obtainable from them and the ease of adjustment of the frequency also give them further advantages over the frequency raising apparatus, which we shall consider later, while, in addition, the oscillations obtained in this manner are much steadier and of more constant frequency than those from any existing form of arc generator. The fact that the same type of apparatus is available for both transmitting and receiving should also lead to a considerable simplification of the construction of the plant necessary at wireless telephone stations equipped on those lines, and corresponding economies in their operation and maintenance.

[*Photo: Frank C. Perkins.*

MR. THEODORE N. VAIL SPEAKING BY WIRELESS TELEPHONE FROM NEW YORK TO MARE ISLAND, CALIFORNIA, 2,500 MILES AWAY.

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Among the Operators

OPERATOR G. J. NICHOLLS

S.S. *ACHILLES.*

Mr. George John Nicholls, operator of the above steamer, comes from Croydon, and is 22 years of age. He received his education at Penge, and afterwards underwent a course of training in wireless telegraphy at the British School of Telegraphy, Clapham Road. After completing his studies at Marconi House he received his first appointment—to the s.s. *Dominion* in June, 1913, afterwards serving for a considerable period upon the s.s. *Huntsman*. Prior to joining the s.s. *Achilles* he had sailed on the s.s. *Knight of the Thistle.*

We understand that Mr. Nicholls has sustained severe injury to his arm, probably from the explosion of a shell fired by the German submarine which sank the *Achilles*. We are sure all of our readers will join with us in wishing him a speedy recovery.

* * * * * *

S.S. *GOLDMOUTH.*

Another victim of German piracy is the s.s. *Goldmouth*, recently torpedoed by an enemy submarine. The operator of this vessel, Mr. R. C. Older, hails from Kingston-on-Thames, and is one of the younger members of the Marconi staff. Educated at St. Mary's College, Harlow, Essex, he decided to take up wireless telegraphy as a profession, and went through a course of training at the British School of Telegraphy, London. From this school he entered the Marconi Company's service in May, 1915, proceeding to sea upon the s.s. *Gaika*, from which he was transferred to the *Goldmouth* in July of that year. We are sorry to hear that Mr. Older received serious injury to his foot as a result of the explosion of a shrapnel shell near by, and at present he is receiving treatment in hospital. We trust that he will make a rapid recovery.

OPERATOR R. C. OLDER

* * * * * *

S.S. *DUENDES.*

Mr. Harry Kidston Sang, who recently went through such thrilling experiences on board the above steamer (see page 210), was born north of the Tweed at Row, in the county of Dumbarton. Although only 22 years old, Mr. Sang has already served three years as a wireless

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operator on the sea, having entered the London School of the Marconi Company in May, 1913. His first appointment was to the s.s. *Minnewaska*, whence he transferred to the *Sicilia*, and thence to the s.s. *Aaro*, *Athenia* (on which he made many voyages), the *Cameronia*, *Pretorian*, and in October, 1915, to the *Duendes*. Prior to joining the Marconi School Mr. Sang received a preliminary course of wireless training at the Glasgow Wireless School. We are glad to say that he escaped from the gunfire uninjured.

OPERATOR H. K. SANG

* * * * *

S.S. *PARISIANA*.

Mr. Samuel Deeming, of Tamworth, the operator of the above vessel, which was recently torpedoed by a German submarine, entered the wireless service in June, 1912, and after completing his training served for two years on the vessels of Messrs. Nicolas Mihanovitch, Ltd., trading on the South American coast. Upon returning to this country he took up an appointment on the s.s. *Glenroy*, a steamer which was wrecked off Singapore within a month of his joining. He then sailed upon the s.s. *Englishman*, *Anglo-California*, *Vandalia*, and was appointed to the s.s. *Parisiana* in April. He was, however, destined to be wrecked a second time, for on the fourth day of her voyage the vessel was torpedoed and sunk by the enemy. Mr. Deeming, who is 22 years old, fortunately escaped without injury.

OPERATOR S. DEEMING

* * * * *

S.S. *SHENANDOAH*.

Many of our readers will have seen in the daily Press a report of the sinking of the s.s. *Shenandoah*, which it will be remembered struck a mine and sank. Mr. Ernest Marshall, a native of Manchester, was in charge of the wireless, and we are sorry to say did not escape unscathed. At the time of writing we are not aware of the extent of Mr. Marshall's injuries, but we trust that he will make a rapid recovery. The *Shenandoah* was Mr. Marshall's third appointment, as he is a comparatively new member of the Marconi Company's operating staff. He is 25 years of age, and received his preliminary training at

OPERATOR E. MARSHALL

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the Universal School of Telegraphy and the City School of Wireless, Manchester.

* * * * *

S.S. *SIMLA*.

The P. & O. Company have had the misfortune to lose several ships in the present war; the s.s. *Simla* being the most recent to go down. Two operators were carried: Messrs. Frederick Wm. Harvey and H. Varley. Mr. Harvey, the senior operator, is a Barnstaple man, and is 28 years of age. On joining the Marconi Company in July, 1912, he proceeded to South America and served for two years on steamers trading on that coast. On his return to England he

OPERATOR H. VARLEY

OPERATOR F. W. HARVEY

was appointed to the s.s. *Mellore*, and transferred a few months later to the s.s. *Harmatris*. He was appointed to the *Simla* in July, 1915. Mr. Varley, the assistant operator, only recently joined the Marconi Company, the *Simla* being his first ship. Before taking to wireless he had some experience in the Post Office as a telegraphist, and this was, of course, of great use to him in studying for his new profession. Mr. Varley's home is in Leeds, and he is 20 years of age. Together with Mr. Harvey he fortunately escaped uninjured.

S.S. *YONNE*.

The s.s. *Yonne*, sunk by a German submarine, carried one operator, Mr. Martin Rohan, of Aughacasla, Co. Kerry. Mr. Rohan commenced his wireless studies at the Atlantic College of Wireless Telegraphy, Cahirciveen, and later came to London to join the Marconi School in the Strand, where he completed his studies. After sailing for one voyage as operator on the s.s. *Saturnia* he was transferred to the s.s. *Kastalia*, which was afterwards renamed the *Yonne*. Mr. Rohan is 23 years old, and is none the worse for his exciting adventure.

OPERATOR M. ROHAN

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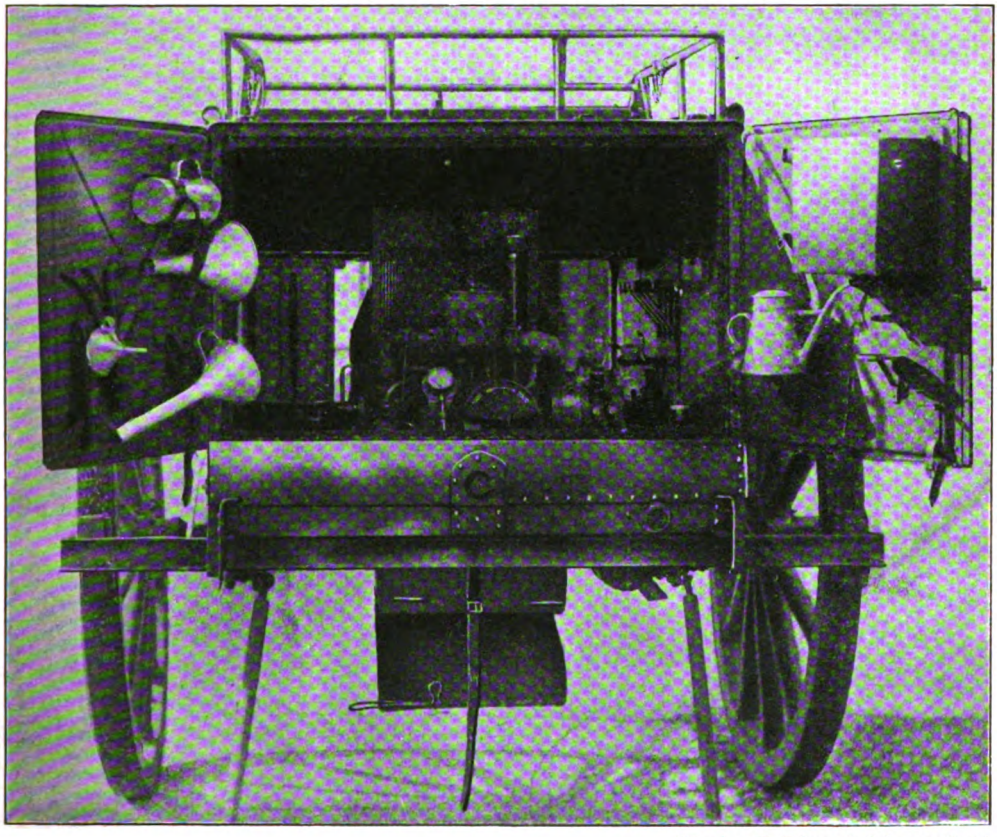
Some Spoils of War

German Portable Wireless Apparatus Captured by General Botha

We are sure our readers will be interested to see the accompanying photographs of the Telefunken Portable Wireless Apparatus captured by General Botha from the German forces in the recent campaign. There is ample evidence to show that the enemy forces were well equipped with portable apparatus and made good use of it.



[*Photo: M. Edward, Johannesburg.*

FIG. I. THE PETROL ENGINE AND GENERATOR.

The photographs in this article are of two such stations, which at the time of the surrender were erected respectively at Karab and Zesfontein, a distance of 250 miles separating the two places. The apparatus for each set is carried on four carts, which couple together in pairs. Figure 1 shows the generating plant. The water-cooled petrol motor has a bore of 95 mm. with a stroke of 110 mm., and runs normally at a speed of 1,500 revolutions per minute. Coupled to the engine is a 500 frequency alternator giving 35 amps. at 85 volts, and a dynamo giving 8 amps. at 50 volts; this latter serves as the exciting dynamo for the alternator.

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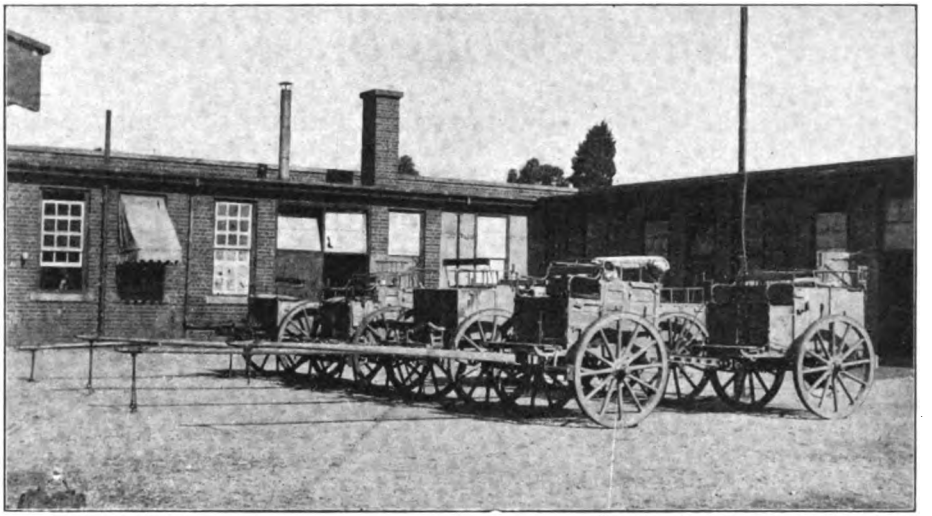
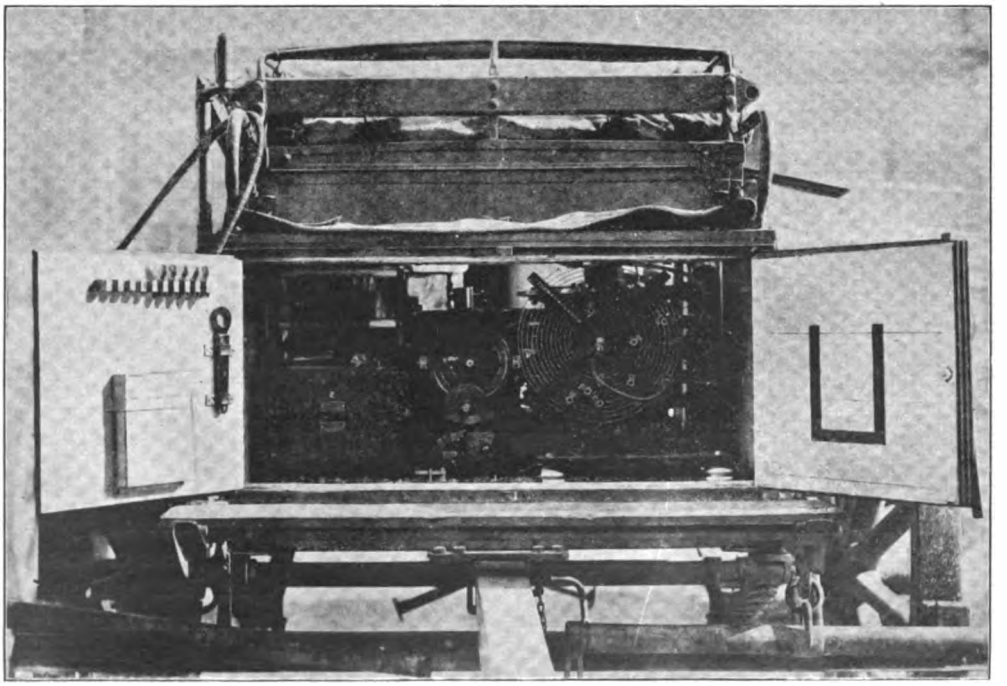


[Photo: M. Edward, Johannesburg.

FIG. 2. THE TWO PORTABLE SETS AT JOHANNESBURG.

In figure 3 we see a transmitting apparatus. On the left is placed a transformer surmounted by a quenched spark gap, and on the right the flat spiral inductance of the auto-jigger. Plug clips have been attached to this spiral inductance in several places, to facilitate rapid changes in wave-lengths. The switch handle and studs to be seen



[Photo: M. Edward, Johannesburg.

FIG. 3. THE TRANSMITTING APPARATUS.

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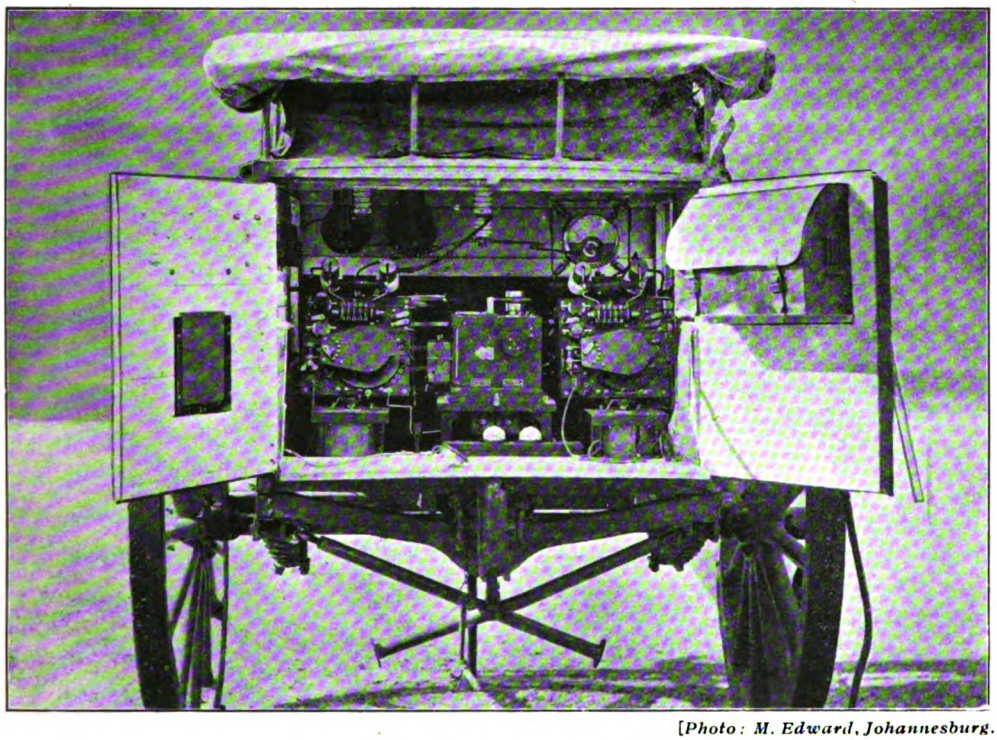
in the centre of the space control the low frequency inductance. The receiving apparatus, which is carried at the other end of the same vehicle as the transmitter, is clearly shown in Fig. 4. Two compete receivers, one on each side, are provided, the aerial lead-in being in the centre. The change from " send " to " receive " is effected by means of the switch visible at the top of each tuner. Coupling is varied by moving the primary closer to or further from the secondary, the latter being mounted on a hinged flat. With the assistance of the variable air condenser in the front of each tuner, wave-lengths from 100 to 3,000 metres can be tuned in, the small two-way switch



[*Photo: M. Edward, Johannesburg.*

FIG. 4. THE DUPLICATED RECEIVER.

visible on the top right-hand corner of each set being used to change from short to long wave-lengths and *vice versa*.

Two crystal detectors are provided for each set, these being mounted on the top left-hand corner of the base boards. Just behind the receiver on the left-hand side the handle of the sending key can be seen. The box between the two receiving sets contains the wavemeter, and above the right-hand tuner will be noticed the hot wire ammeter for measuring the current in the aerial. As already mentioned, the aerial lead-in is shown in the centre of the roof of the cart, the smaller insulated terminal to the left being connected to the earth or balancing capacity. The large leather bag hanging on the right-hand door carries the necessary stationery.

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Instructional Article

NEW SERIES (No. 10).

The following series, of which the article below forms the tenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Graphical Solution of Equations.

72. In the previous article we dealt with the plotting of curves on squared paper, and we shall now proceed to consider the application of such curves to the solution of equations.

To start as usual with a very simple example, we will take the equation

$$17x - 15 = 0.$$

In place of the 0 on the right-hand side of the equation put y, so that

$$17x - 15 = y.$$

The solution of the original equation is obviously obtained if we find the value of x for which $y = 0$, as then we should have

$$17x - 15 = y = 0, \text{ or } 17x - 15 = 0.$$

Now tabulate pairs of values of x and y as follows :—

$x =$	4	2	0	-2
$y =$	53	19	-15	-49

Plotting these values we obtain a straight line, as shown in Fig. 52.

Now the only possible positions for the points $y = 0$ lie along the horizontal axis through the origin, and one such point is P where the curve $17x - 15 = y$ crosses this axis. This point P thus satisfies the *two* equations $17x - 15 = y$ and $y = 0$, and accordingly its x value is the solution of the equation $17x - 15 = 0$.

It will be seen that the solution is approximately $x = 0{\cdot}9$. Now if the result is required correct to a higher degree of accuracy we can obtain it by plotting to a larger scale a small portion of the curve on either side of the point P.

In order to do this we need to calculate two values of y (or more than two when the curve is not a straight line) for values of x just smaller and just greater than 0·9.

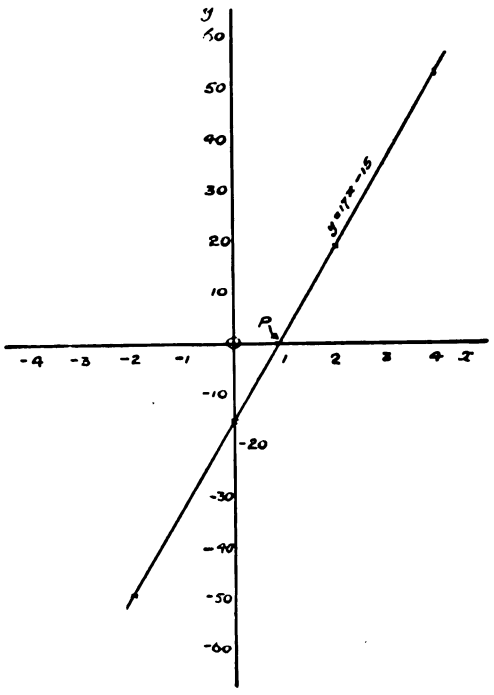

FIG. 52.

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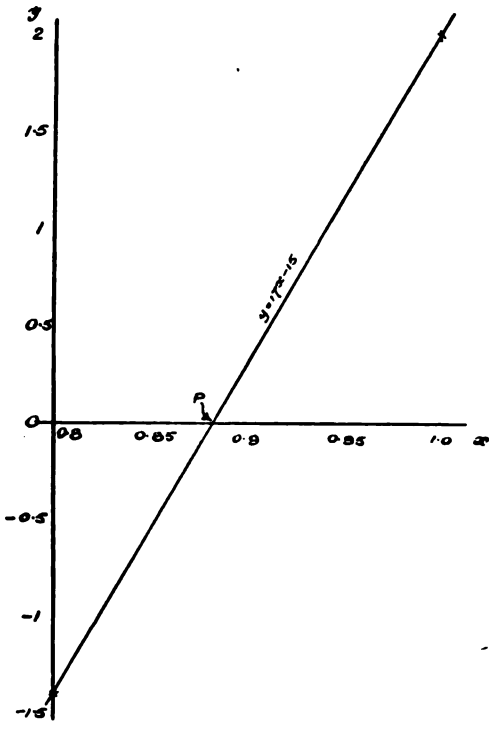

FIG. 53.

The latter being the more usual method, we will use it in the present case.

Tabulating values—

$x=0$	1	2	3	-1	$2\frac{1}{2}$	$-\frac{1}{2}$
$y=-7$	-11	-5	$+11$	$+7$	$+1\frac{3}{4}$	$-1\frac{1}{4}$

It will be noticed that values of y have been worked out on either side of $x=0$, that is for positive and negative values of x; also that when it was evident that solutions would be obtained

(1) between $x=2$ and $x=3$

and (2) between $x=0$ and $x=-1$, the extra values of y for $x=2\frac{1}{2}$ and $x=-\frac{1}{2}$ were worked out. These two latter values will give us points on the curve close to the points we have to find.

On plotting the curve we obtain Fig. 54. In this case the curve is not a straight line on account of the equation being of the ***second*** degree; that is, con-

For example, if $x=0{\cdot}8$, then $y=-1{\cdot}4$
and if $x=1{\cdot}0$, then $y=+2$.

This portion of the curve is shown plotted in Fig. 53, and it will be easily seen that the accuracy with which we can read off the value of x at the point P is much greater than before. We can read off $x=0{\cdot}882$ (approx.), and if we cared to work out the values of y when $x=0{\cdot}881$ and $x=0{\cdot}883$ and plot them, we should obviously obtain a still more accurate result.

73. To take another case, let us solve the equation

$$5x^2-9x=7.$$

This equation being a quadratic, we shall expect to obtain *two* values of x as solutions.

We can either put $5x^2-9x=y$ and from the curve find the values of x for which $y=7$, or we can put $5x^2-9x-7=0$ $=y$ and find the value of x for which $y=0$.

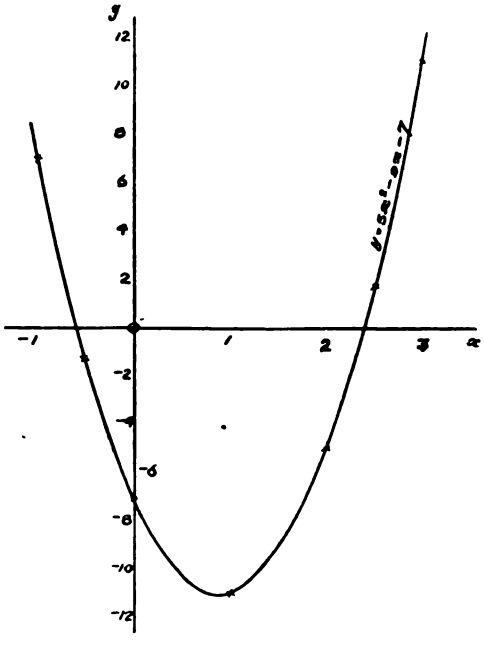

FIG. 54.

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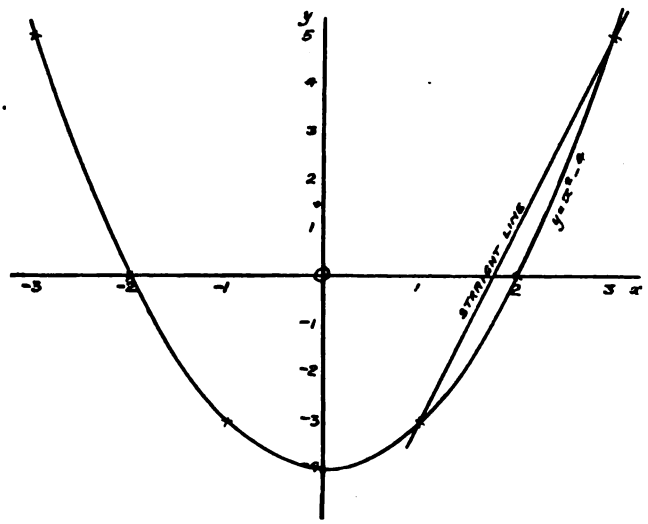

FIG. 55.

a fair curve drawn through all these points. We might, for example, work out the values of y for $x=2.3$, 2.4 and 2.5 in order to obtain one of the values.

74. To make this last point somewhat clearer, let us consider the very simple quadratic

$$x^2-4=0,$$

the correct solution of which is obviously $x=\pm 2$.

Put $x^2-4=y$, and tabulate values—

$x=$	3	1	0	−1	−3
$y=$	5	−3	−4	−3	5

Plotting these values (Fig. 55) the curve, as we should expect, crosses the x-axis at $x=2$ and $x=-2$, that is, at (2, 0) and (−2, 0). If, however, we simply plot the two pairs of values

$$x=1,\ y=-3$$
$$\text{and } x=3,\ y=5$$

and join them with a straight line, we find that this line will cut the x-axis at the point $x=1\frac{3}{4}$ (approx.), thus introducing an error of $\frac{1}{4}$ or $12\frac{1}{2}$ per cent.

As against this, however, we should find that if we calculated y for $x=1{\cdot}99$, $x=2{\cdot}00$ and $x=2{\cdot}01$, values which are taining a term ($5x^2$) which involves the *second* power of x.

It will be seen from the curve that the two solutions of the quadratic are approximately

$x=2.4$ and $x=-0.6$.

We can, as before, plot the portions of the curve near these values to a larger scale if we wish to obtain more accurate results. It must be remembered, however, that as we are now dealing with a *curved* curve, more than two points must be plotted in each case, and

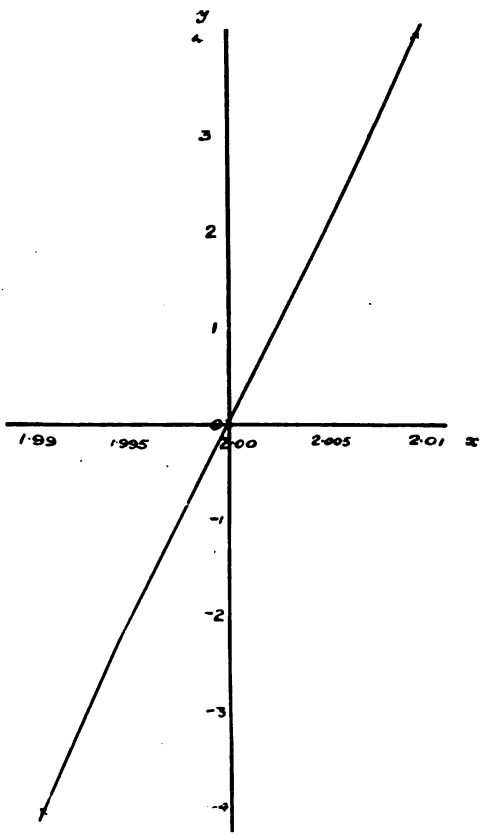

FIG. 56.

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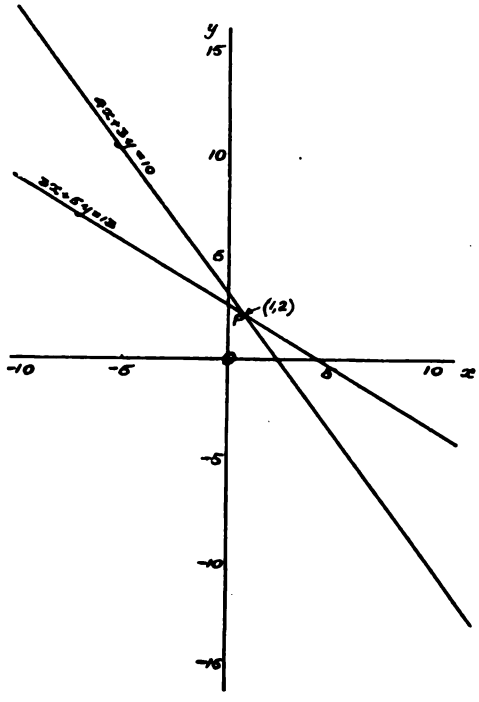

FIG. 57.

very near together, then these three values would lie so nearly on a straight line that it might be sufficiently accurate to draw a straight line through them.

Thus—

$x=1{\cdot}99$	2	2·01
$y=-0{\cdot}0399$	0	0·0401

Plotting these values (Fig. 56) we see that the three points lie as nearly as possible on a straight line.

If, however, we had been dealing with points near the *peak* of the curve instead of on the straight part, then we should have found a greater disagreement between the curve and the straight line.

75. The next question to consider is the graphical solution of *Simultaneous Equations*.

Let us take—

(1) $4x+3y=10$

(2) $3x+5y=13$.

These equations, being of the first degree, will give straight line curves, and so we need only work out two pairs of values for each.

Rearranging them somewhat we get—

$$(1)\quad 3y=10-4x$$
$$\text{or } y=\frac{10-4x}{3}$$
$$(2)\quad 5y=13-3x$$
$$\text{or } y=\frac{13-3x}{5}$$

Tabulating—

(1) $y=\dfrac{10-4x}{3}$

$x=+10,\ y=-10$

$x=-10,\ y=16\frac{2}{3}$

(2) $y=\dfrac{13-3x}{5}$

$x=+10,\ y=-3\frac{2}{5}$

$x=-10,\ y=8\frac{3}{5}$

Plotting these two lines (Fig. 57) we see that they cross at the point (1,2).

Now every point on one curve satisfies the equation $4x+3y=10$, and every point on the other curve satisfies the equation $3x+5y=13$. Therefore *the point where the two curves cross will satisfy both equations*, or in other words will give us the solution of the simultaneous equations. Now at this point (1, 2) we have

$$x=1,\ y=2,$$

and so these values are the solution we require.

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76. As a rather different example let us take the two equations

$$(1)\ xy=25 \quad \text{or } y=\frac{25}{x}$$

$$(2)\ 2x-y=4 \text{ or } y=2x-4$$

Tabulating—

(1) $y=\frac{25}{x}$

$x=10$	5	$2\frac{1}{2}$	0	$-2\frac{1}{2}$	-5	-10
$y=2\frac{1}{2}$	5	10	∞	-10	-5	$-2\frac{1}{2}$

(2) $y=2x-4$

$x=$	7	-3
$y=$	10	-10

Fig. 58 shows these two curves plotted out. One thing to notice is that the curve $xy=25$ occurs in two parts. These two parts, apparently separate, are really one curve, being joined together at infinity.

The two curves cut at the points (4·7, 5·4) and (−2·6, −9·4), and so the required solutions are--

$$x=4\cdot7,\ y=5\cdot4$$
$$x=-2\cdot6,\ y=-9\cdot4$$

Determination of Laws of Curves.

77. It often happens, after carrying out some experiment, that we have a set of readings of two quantities, the law connecting which has to be found. We will proceed to examine the case in which the curve plotted from the readings is a straight line.

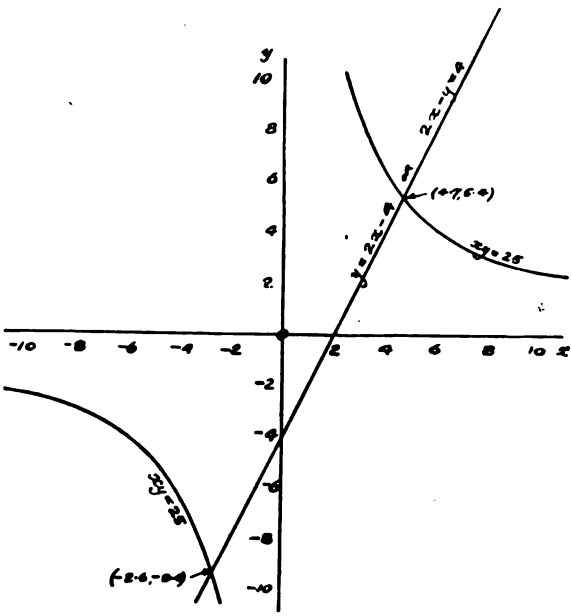

FIG. 58.

In Fig. 59 we have a curve AB passing through the origin, and lying in the first and third quadrants. If we take a point P on this curve we find that here

$$x=2 \text{ and } y=3. \quad \text{Thus } y=\frac{3}{2}x.$$

Taking a second point Q we find that here

$$x=4 \text{ and } y=6. \quad \text{Thus, again,}$$
$$y=\frac{6}{4}x=\frac{3}{2}x.$$

Taking the point R on that portion of the curve which lies in the third quadrant, we find here that $x=-3$ and $y=-4\frac{1}{2}$.

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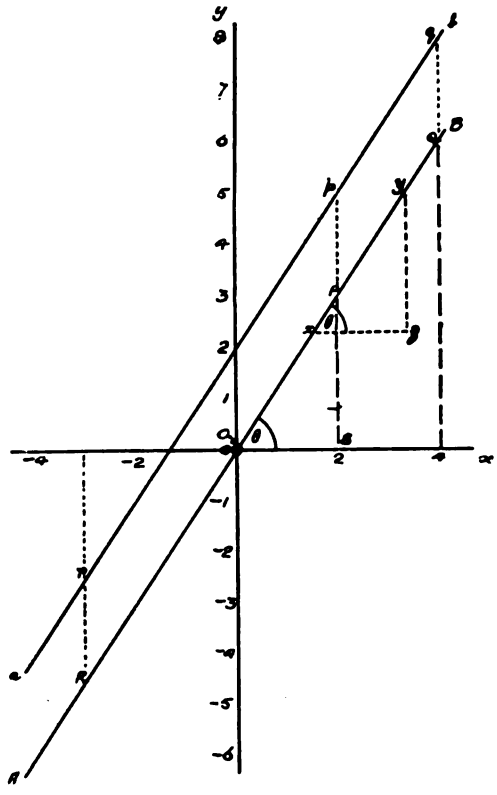

FIG. 59.

Thus $y=\frac{-4\frac{1}{2}}{-3}x=\frac{3}{2}x$ as before.

The law of this curve is obviously $y=\frac{3}{2}x$, or $2y=3x$, or $3x-2y=0$, and it has been found by the simple process of taking a point on the curve and reading off the values of x and y at that point.

Let us, however, consider the parallel curve *ab* which *does not pass through the origin*.

At the point p, $x=2$ and $y=6$.

Thus $y=3x$

At the point q, $x=4$ and $y=9$.

Thus $y=\frac{9}{4}x=2\frac{1}{4}x$.

At the point r, $x=-3$ and $y=-2\frac{1}{2}$.

Thus $y=\frac{-2\frac{1}{2}}{-3}x=\frac{5}{6}x$.

In this case, as all these three equations are different, we have not succeeded in finding any law for the curve.

Returning for a moment to our first curve AB, it is quite obvious that the ratio of y to x, or $\frac{y}{x}$ will be given by the ratio $\frac{PS}{SO}$ of the two sides of any such triangle as the triangle OPS. Now we know that $\frac{PS}{SO}$ is the tangent of the angle POS, or *the tangent of* the inclination θ of the curve to the horizontal axis. We need not take the x-axis as one side of the angle, but we can draw any such triangle as the triangle xyz, where xz is parallel to the x-axis and zy parallel to the y-axis. The ratio $\frac{yz}{zx}=\tan\theta$.

On comparing the two curves AB and ab we see that at the points P and p, say, the value of x is the same, but the value of y at p is equal to its value at P *plus* 2. This applies all along the curves, and so we can say that the values of y for the curve *ab* equal the corresponding values for the curve AB plus 2. But for the curve AB we have the law $y=\frac{3}{2}x$, and so the law of the curve *ab* is $y=\frac{3}{2}x+2$

or $y=x\tan\theta+2$.

To proceed a step further, we see that the last term 2 is the value of the intercept along the vertical y-axis from the origin to where the curve cuts this axis, and we infer from this fact that the law of the curve is

$$y=mx+c$$

where $m=\tan\theta$

and $c=$intercept on y-axis.

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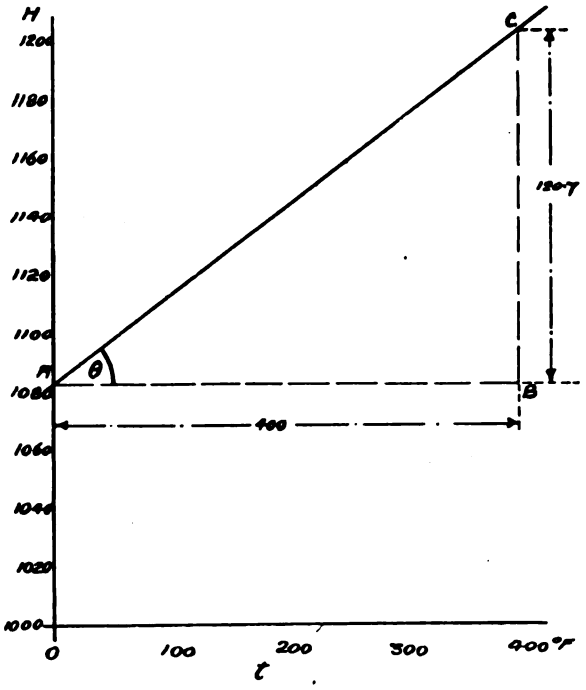

FIG. 60.

This form of the equation is a perfectly general one covering all cases of straight line curves.

The curve CD (Fig. 59) has the law

$$y = -\frac{1}{2}x - 1.$$

Example :—

The following values of the Total Heat (H) of 1 lb. of steam at various temperatures (t) are abstracted from steam tables. Find the law connecting H and t.

t=202° F., 250·3, 302·8, 350·0, 401·1

H=1143·6 units, 1158·3, 1174·3, 1188·7, 1204·0

On plotting these we get the curve of Fig. 60. The first thing to notice is that c=1082·5.

To obtain m we will take the triangle ABC, purposely making it as large as possible in order to obtain m with greater accuracy. The base AB should be made a convenient value (in this case 400) for dividing out.

To obtain the length of BC we subtract the vertical value or ordinate of B from that of C. This gives us BC=1203·2−1082·5=120·7.

Thus $m=\tan\ 0=\frac{121\cdot5}{400}=0\cdot302$ (nearly).

From this we get the law as

$$H=0\cdot302t+1082\cdot5$$

[The correct result is $H=1082+0\cdot305t$.]

The biggest probability of error in this particular case lies in producing the curve such a long way back in order to obtain the intercept value c, in other words it lies in the exterpolation operation.

We could have avoided this exterpolation in the following way. Fig. 61 is the same curve plotted to a larger scale, and from it we get the following two pairs of values—

t=200°F H=1142·8

t=400 H=1203·2

Thus in the 200°F from 400° to

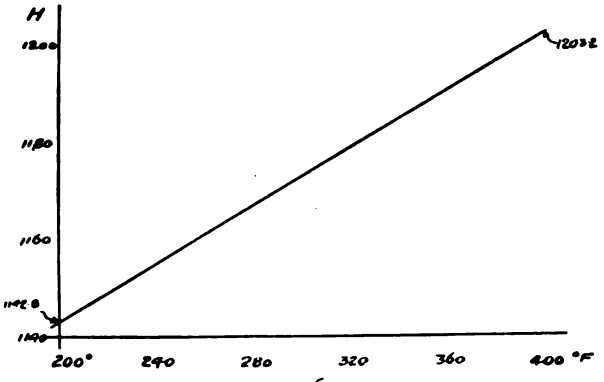

FIG. 61.

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200°, H has been reduced by (1203·2 − 1142·8) or by 60·4 units. Therefore, since the curve is a straight line, in the next 200° down to where $t = 0°F$, H will be reduced by a further 60·4 units, and will then be equal to 1142·8 − 60·4 = 1082·4 units. We have thus *calculated* the value of C instead of drawing the curve right away back and reading it off.

Recreations of a Wireless Operator

Lines inspired by the article on "The Banjo" which appeared in our April number.

Oh when upon the waters' crest
The heart cries out for music blest,
I seek—and find—sweet mental rest
  Playing on me old banjo!
When the incessant buzzings cease,
Or blessed X's bring me peace,
The joys of life so swift increase,
  Playing on me old banjo.

Ah, let the foolish cynics sneer,
No carping critics do I fear;
The sacred sounds I still hold dear,
  Playing on me old banjo.
My thoughts are lost in wondrous sound,
I care for nothing that's around,
For calm forgetfulness I've found,
  Playing on me old banjo.

No longer skins disturb my mind.
Mistakes and faults let others find,
For I am always wondrous kind
  When playing on me old banjo.
Yet still the guilty sinners quake;
For, tho' my dreams long moments take,
On each occasion I awake
  From playing on me old banjo.

PAN.

Readers, Please Note

Owing to pressure on our space it has been found necessary to hold over from the present issue our monthly article devoted to "Pastimes for Operators," as well as our account of the part played by radio-telegraphy in the recent trouble in Ireland.

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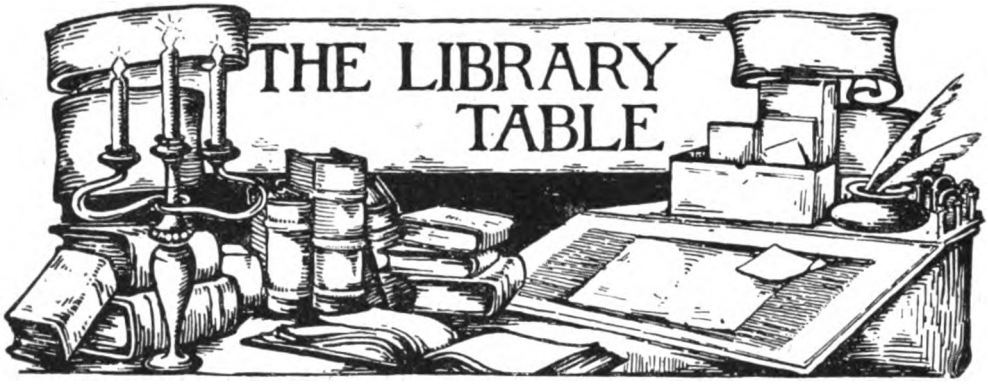

"THE SPY HUNTER." By William Le Queux. London, 1916: C. Arthur Pearson, Ltd. 1s. net.

A more thrilling narrative of the chasing and cornering of German spies in England during the present war it would be hard to imagine. The stories form records of the adventures of Harry Nettlefield, an ex-wireless operator, and his *fiancée* Clotilde. Although, naturally, Mr. Le Queux has had to hide his personalities under fictitious names, the accounts are based largely on fact. They form eloquent testimony to the apathy of the British authorities in the earlier days of the war.

The whole country at that time was under the thumb of probably the cleverest spy organisation in the world, whose doings were controlled by the Master Spy, Steinhauer, in Berlin. In many instances the spies were found to be living the country life of ordinary English men and women, although it is a remarkable coincidence that these people almost invariably lived in houses standing alone in the middle of large grounds, and generally a fair distance from any main road.

Purely from the point of view of personal interest the book appeals to us, with one exception. We think that the prowess of Clotilde is very much overdone. It is somewhat wearisome to read in almost every chapter of her "exceeding great bravery." However, we do not wish this little piece of adverse criticism to assume undue proportion in the eyes of our readers. The book should afford much pleasure to those who peruse it.

* * * * * *

"DIRECTIONS FOR DESIGNING, MAKING, AND OPERATING HIGH-PRESSURE TRANSFORMERS." By Professor F. E. Austin. Hanover, N.H.: Professor F. E. Austin. 3s. net.

This is an interesting and clearly written little book, particularly valuable to the serious student of wireless and to the operator who is anxious to understand thoroughly the principles and construction of the component parts of his installation.

The author introduces the subject by referring to the commercial demand and necessity for electric power at high pressure, and the reasons why alternating current is the most useful for this purpose. A simple but very practical explanation of the construction of the transformer then follows, after which we find an explanation of symbols and annotation, the various losses in a transformer, power factor, and other matters. The author next treats of the design of a-20,000 volt transformer, entering very carefully into practical details of calculation. Following this, we have a chapter entitled "Directions and Data for Constructing a 3-KW. 20,000-volt Transformer,"

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the approximate cost of materials not being overlooked. A further chapter deals with data applying to a 4,000-volt transformer.

We do not remember having previously seen any small book dealing so thoroughly and practically with the construction of high-pressure transformers, nor one in which the diagrams and photographic illustrations were so happily chosen. The impression we have gained after reading the book is that the author knows exactly what he is talking about and how to express himself. The transformers described may not be of the very highest efficiency, but a study of their construction cannot fail to be of the greatest value to both wireless amateur and professional operator.

* * * * * *

"WIRELESS TELEGRAPHY AND TELEPHONY: A HANDBOOK OF FORMULÆ, DATA, AND INFORMATION." By W. H. Eccles, D.Sc., A.R.C.S., M.I.E.E. London: "The Electrician" Printing and Publishing Co., Ltd. 12s. 6d. net.

A handbook on wireless telegraphy from the pen of an expert of such standing as Dr. Eccles will be welcomed, we are sure, by a wide circle of readers. In the preface the author informs us that whilst the book is a classified collection of information, data, formulæ, and tables likely to be helpful to designers and investigators in radio-telegraphy, nevertheless, the intention has been not only to set out a bare statement of facts in an easily accessible form, but to give brief accounts of the position of modern thought and speculation; this is without allowing the book to become an expository treatise.

A glance through the volume shows that it is divided into four sections—the first containing tables; the second, formulæ; the third (by far the largest section), general information; and the fourth a glossary.

Prominent among the useful features in the first part of the book is an "abac" for rapidly finding the relations between the wave-length, self-inductance, and the capacity of a circuit. With the aid of a thread stretched across the abac chart, the wave-length of a circuit containing a given capacity and inductance can be ascertained in a moment, thus saving considerable time otherwise occupied in calculation. The inductance of a circuit with a given capacity and wave-length, and the capacity with a given inductance and wave-length can also be found equally rapidly. This "abac," which opens out to a size four times as large as the page of the book, is bound into the volume in such a way that it can be readily detached by tearing through a line of perforation. Other most useful abacs are interspersed throughout the book.

In compiling the two sections devoted to tables and formulæ, the author has consulted the chief standard books of mathematical and physical tables, as well as many original papers, and the mass of information so gathered is of great practical use. The third section is really a series of articles on various subjects, and will, we think, prove by far the most popular division. There are a few points which we would venture to criticise. For instance, on page 222, Fig. 148, showing the circuits used by Round with a single vacuum tube, the battery is missed out in the filament circuit, although the series variable resistance is shown.

Again, on page 242, under the heading "Methods of Mounting the Active Substance," we read the following: "In the case of the carborundum detector, a crystal . . . is grasped between two flat brass springs, so that it is held firmly," whereas at the present time in practically all the commercial forms of carborundum detector the crystal presses against a *steel* plate. On page 314, Fig. 255, the leads from the transformer are shown taken directly to condenser, a method abandoned by the Marconi

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Company in favour of connections to the discharger, as in this way there is less risk of breakdown of transformer insulation.

On page 353 we find considerable confusion. Under the heading "United Wireless Telegraph Company's Plant" the following surprising statement occurs: "The United Wireless Telegraph Company was absorbed in 1912 by the American Marconi Company. The plant used by the former firm and its predecessor (The 'National') is of interest, though now out of date in certain details." Then follows a description of a 10-KW. Fessenden transmitter. The error is that the United Wireless Telegraph Company never had any connection whatever with the National Electric Signalling Co. (The "National"), and both ran in competition with one another for many years. The Fessenden apparatus here described is that exploited by the National Electric Signalling Company, and the heading should therefore be "National Electric Signalling Company's Plant." There is no description whatever of the United Wireless apparatus. These points, however, will doubtless be corrected in a subsequent edition.

The section of the book containing the glossary has not, we are afraid, received the careful attention that it merits. A number of definitions are missing; for instance, we find no mention of "Æther," "Converter" (although motor generator finds a space), "Insulator" or "Tuner." The definition of "recorder," although it apparently endeavours to be complete, entirely omits reference to photographic methods which have been used from time to time. The definition of relay, too, might well be modified to cover the well-known wireless relay of S. G. Brown. One other little matter we would draw to the attention of the publishers; on page 387 we find a footnote, "Glossary and Index *follow*," although the index is to be found in the *beginning* of the book.

Although of a size too large to be placed in the category of "Pocket Books," the volume before us is yet of a convenient form, a large amount of matter being compressed into a comparatively small space by the use of small type and thin paper.

Altogether the book merits considerable praise both for the amount of interesting and valuable matter contained therein, and also for the manner in which it has been edited. We do not know of any other book in which so much valuable and interesting information regarding the various so-called "systems" is brought together in such convenient form.

* * * * * *

"EXAMPLES IN MAGNETISM FOR STUDENTS OF PHYSICS AND ENGINEERING." By F. E. Austin, B.S., E.E. Published by the Author at Hanover, N.H. 5s. net.

This is a book similar in style to "Examples in Alternating Currents," by the same author, reviewed in our March issue. The plates are particularly interesting and helpful, as they show the lines of force surrounding magnets by means of actual photographs of iron filings. This is a great improvement on the old method of drawing an imaginary field with a few dotted lines, and should be much appreciated by the student.

The problems and examples seem carefully chosen and well worked out, and should furnish a guide to students who are beginning to study electrical engineering, and enable them to develop the process of correct and logical thinking.

The book is well produced, and will prove valuable to both students and instructor. As in the case of "Examples in Alternating Currents," we would register a mild protest against the use of green ink for the printing, and we think the book would be improved by the title being printed along the back, so that it could be rapidly identified amongst other similar books on the bookshelf.

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Patent Record

1595. February 2nd. R. C. Galletti and Galletti's Wireless Telegraph and Telephone Co. Transmitting apparatus for wireless signals.

1597. February 2nd. Emile Girardeau and J. Bethenod. Radio-telegraphy. (Convention date, February 2nd, 1915, France). (*Open to public inspection.*) (Patent No. 100,058.)

1705. February 4th. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for controlling alternating currents.

1825. February 7th. J. Gell. Electric arc generators for high frequency oscillations.

1827. February 7th. Basil Binyon. Apparatus for wireless telegraphy.

1861. February 8th. M. B. Rodriguez. Syntonisation, by frequency, of groups of electro-magnetic waves.

2066. February 11th. E. R. Clarke. Wireless telegraphy.

2065. February 11th. Emile Girardeau and J. Bethenod. Radio-telegraphy. (Convention date, February 11th, 1915, France.) (*Open to public inspection.*) (Patent No. 100,075.)

2329. February 16th. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for producing alternating currents.

2402. February 17th. A. Artom. Signalling by electro-magnetic waves.

2524. February 19th. T. B. Dixon. Transforming motion into electrical waves or impulses. (Convention date, July 19th, 1915, United States.)

2598. February 21st. Ettore Bellini. Device for generating in an aerial for wireless telegraphy and telephony electrical oscillations having a strictly single frequency.

2639. February 22nd. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for amplifying electrical variations.

2861. February 25th. Marconi's Wireless Telegraph Co., Ltd., and Frank P. Swann. Receivers for wireless signals.

2922. February 28th. M. J. Webb. Oscillatory machines.

2976. February 28th. Gogu Constantinescu and Walter Haddon. Variable capacity for wave transmission systems.

3006. February 29th. E. A. Lambert. Ship's telegraphic apparatus.

3036. February 29th. British Thomson-Houston Co., Ltd., and N. Shuttleworth. Polyphase alternating current commutator machines.

From the "Western Mail."

"I wish to heaven it was wireless telegraphy, that I do!" was the heartfelt growl of a workman at Lisvane as he wrestled with the awful tangle of wires and connection, the result of a blizzard.

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Personal Notes

The first intimation of honours won received by friends of people serving in His Majesty's Forces is often a notice in the paper of the fact that the men are to be decorated with medals, or other distinction, as a reward for conspicuous bravery or gallantry. We publish a photograph of Warrant Telegraphist John Britten, who was invested at Buckingham Palace, by His Majesty the King, with the Distinguished Service Cross. We offer him our sincere congratulations.

* * *

Photo: Central News.

WARRANT TELEGRAPHIST JOHN BRITTEN.

Shortly after the outbreak of war the staff at Marconi House was very considerably depleted; not only were reservists called to the colours, but with that patriotic instinct so characteristic of the Englishman many younger members of the staff joined His Majesty's forces. We have to record that Donald Marshall, a messenger, on the 17th of April last, enlisted in the 15th Lancers as a bugler. He joined the company on January 19th, 1915.

* * *

It is with regret that we have to chronicle the death on active service of Monsieur René Paul Demont, who prior to joining the French Army was an engineer in the service of the Marconi Company. At the time war broke out he was in Bolivia, energetically pursuing the company's interest in the South American Republic. Before leaving that part of the world, to take an active share in his country's fight for freedom, he rendered valuable service to the Allies' cause Immediately upon his return to his native land he was entrusted with the construction of an important wireless station in the south of France, and when that was completed he achieved the object he had had in mind for some time by joining the Aviation Corps of the French Army. By his own wish he was appointed machine gunner, and it was in fulfilment of this work that he met his untimely death. Monsieur Demont worked in several parts

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MONSIEUR RENÉ DEMONT.

the deceased gentleman. The former shows him as he appeared while prospecting in Bolivia, and the latter indicates him in the dress of an aviator at the Front. This was taken quite recently.

* * * *

The very magnitude and world-wideness of wireless telegraphy in its present stage has tended to obscure the fact that all the Great Powers owe their first realisation of its importance, and are indebted for their initial guidance in this applied science, to Senatore Marconi and the companies formed to carry out his ideas and his inventions. The biographical notice of Mr. W. W. Bradfield, which we publish with his photograph on page 175 of this issue, would, if space permitted, have demonstrated this fact. But, if we had attempted there to develop and adequately treat the subject, our biographical notice would have swallowed up every page of our present issue. Joining the Wireless Telegraph and Signal Company in 1897, within three months of its inception, Mr. of the Western Front, but most of his time was spent in the Champagne District.

General Joffre, in Army Orders, eulogised him thus :

" He volunteered to serve his " country for the duration of the " war, although his military obli- " gations had long since lapsed, " and he asked to be appointed a " machine gunner in the Air " Service. On the 8th March, " 1916, he met a glorious death " in the enemy lines during the " course of an aerial combat."

We are fortunate in being able to reproduce two photographs of

AVIATOR RENÉ DEMONT.

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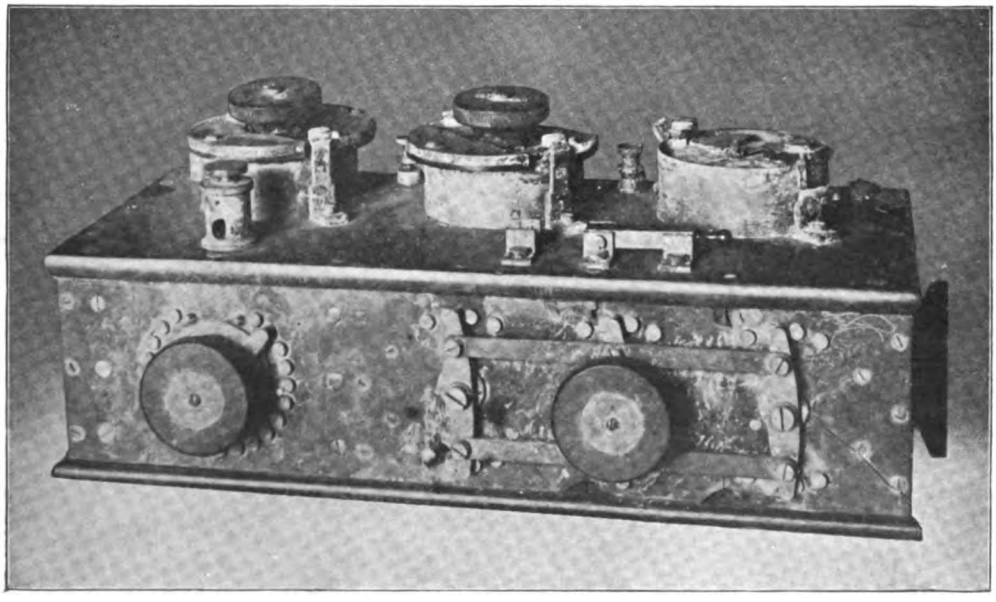
Bradfield took an active share during the course of 1899 in proving the value of wireless telegraphy not only to the British, but also to the United States Navy, the successful official demonstrations carried out on board H.M.S. *Juno* and the United States battleship *Massachusetts* having been conducted under his supervision. On page 173 we give an account of the first stations installed in Germany on the Borkum Lighthouse and the Borkum Riff Lightship. The first permanent ship installation, that on the *Kaiser Wilhelm der Grosse*, was also erected under his guidance. The French Government yielded to the conviction wrought by Mr. Bradfield's demonstrations in 1901, afterwards putting into his hands the erection of their first stations connecting Antibes, in the French Riviera, with Calvi, in Corsica. As far as Italy is concerned, Senatore Marconi has always taken the radio-telegraphic machinery of his Motherland under his own personal guidance. The Russian company founded in 1908, under the supervision of Senatore Marconi, was incorporated in the same year, and has supplied the Russian Government with a large number of radio-telegraphic stations. Thus it will be seen that all the Great Powers of the world owe not merely the practical application of the science, but also the inception of their own individual organisation thereof, directly to Senatore Marconi and those who have for so long been associated with him. Amongst these the subject of our biographical notice, Mr. W. W. Bradfield, takes high rank.



THE ABOVE PHOTOGRAPH SHOWS THE MULTIPLE TUNER OF THE ILL-FATED STEAMSHIP "FALABA," AFTER LYING ON THE BED OF THE OCEAN FROM MARCH 3RD UNTIL OCTOBER 29TH, 1915. ON THE LATTER DATE IT WAS PICKED UP IN A TRAWL AND DELIVERED TO THE RECEIVER OF WRECKS AT MILFORD HAVEN, SUBSEQUENTLY BEING FORWARDED TO THE LONDON OFFICE OF THE MARCONI COMPANY.

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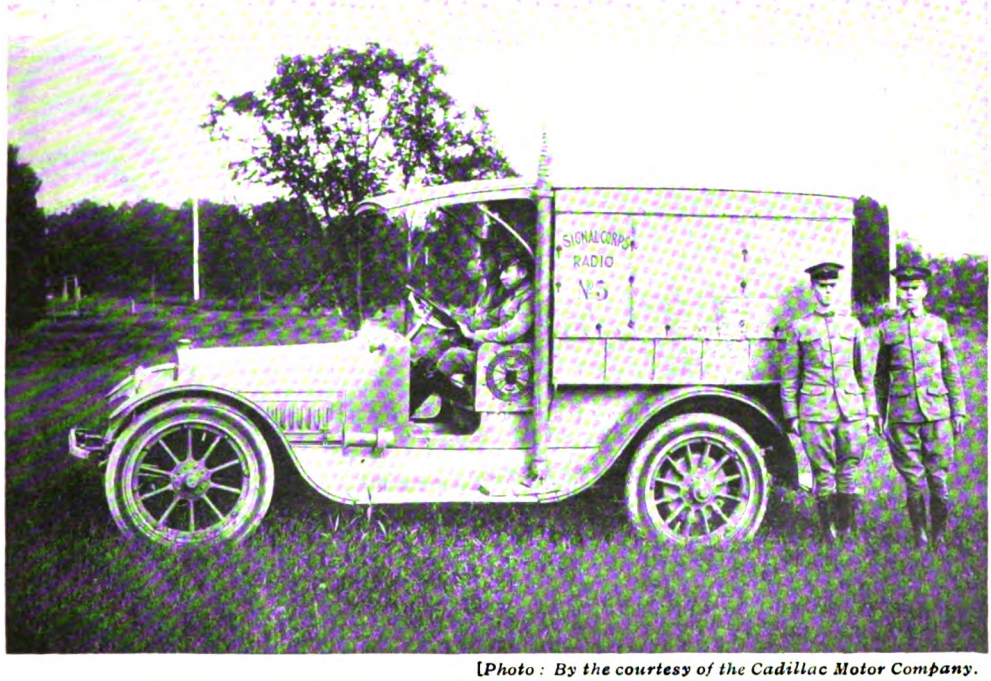
A "Wireless" Automobile

A New Military Car for the United States Army

WE have in the pages of this journal from time to time commented on the progress made by wireless telegraphy in the field, and given illustrations of various sets of apparatus. These have included pack sets, cart sets, cycle sets, hand sets, and automobile sets. Of this latter we are enabled, by the courtesy of the Cadillac Motor Co., to publish a very fine photograph. The car in question forms one of a fleet of eight military cars belonging to the United States army. These motors left Chicago recently for the Pacific coast under the command of Col. R. P. Davidson, commandant of the North-Western Naval and Military Academy, accompanied by Lieut. E. G. Arneman, official observer for the War Department. These cars are equipped with complete wireless outfits, the telescopic mast of which is well indicated on the accompanying illustration. An electric generator, etc., has been installed on every car, and the whole in each instance mounted on a Cadillac eight-cylinder chassis. The present European war has demonstrated the utility of these mobile wireless units, and their adoption by the United States army marks a further important step in the manifold uses to which the science of radiotelegraphy has already been put.



[*Photo: By the courtesy of the Cadillac Motor Company.*

CADILLAC AUTOMOBILE FITTED WITH WIRELESS TELEGRAPHIC APPARATUS, AND BELONGING TO THE UNITED STATES ARMY.

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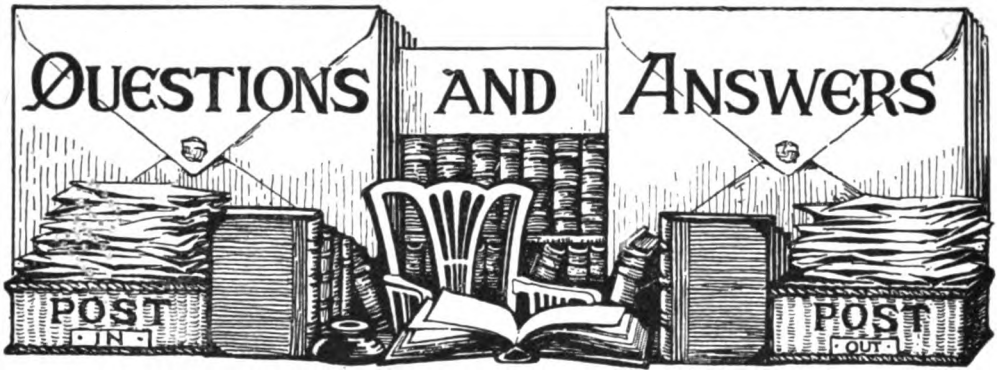

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.*

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

W. J. (Newcastle-on-Tyne) writes: "I have "received a letter from the Postmaster-General "giving me permission to use 'a tapping key, "'buzzer and a telephone receiver, with a "'resistance not exceeding 200 ohms for prac-"'tising the Morse Code.'" He wishes to know if such an arrangement would be of any use, and if so, what the cost would be.

Answer.—The apparatus mentioned would certainly be of the greatest use in learning to send and receive. The cost depends upon the quality of the apparatus. Messrs. Graham & Latham, Ltd., 104 Victoria Street, S.W., whose advertisement will be found in this issue, make excellent apparatus of this kind, and we would advise our correspondent to write to them for particulars, mentioning that he has received the above permit.

P. W. (East Ham).—The power of a wireless installation is usually reckoned at the primary of the transformer. In the case you mention reference is made to the alternating current terminals of the generator. Power can be decreased by loosening the coupling of the jigger or by increasing the L.F.I.C.I. Reducing the speed of the machine decreases the power in certain circumstances by putting the low-frequency circuits out of resonance. You are not correct in your assumption that when the coupling of the jigger is loosened the condenser only partially discharges. With very loose coupling less energy is radiated because more is absorbed in resistance. If the coupling is moderately tight, the energy passes into the aerial fairly rapidly and there are not many oscillations in the closed circuit. If the coupling is so loose as to be negligible the oscillations in the primary will still cease after a time although practically nothing is radiated, as little by little the energy will be absorbed by the resistance of the spark and the rest of the circuit. You will now see that if the energy can be passed into the aerial and radiated quickly the loss in the closed circuit through resistance will be smaller, and the energy radiated will be greater. In reply to your last question, with a 50-cycle alternating current and a fixed discharger there will be at least 100 sparks per second, provided the circuit is not specially adjusted so as to give only one spark for two or more alternations.

S. J. M. (Tunbridge).—There is no medical test in the Postmaster-General's Examination, but the Marconi Company require all applicants to be medically examined before acceptance.

A. P. (King's Lynn) asks four questions, the first two of which are meaningless, as he has evidently become confused somewhere. In the remaining questions he asks: (1) For what purpose is the small condenser across primary of telephone transformer, also the condenser placed across telephones? (2) He presumes the earth arrester gap would not be required in an aerial only used for transmitting.

Answer.—(1) The condensers placed across the primary and secondary of the telephone transformer are for the purpose of tuning, more or less exactly, these circuits to the frequency of the spark of the signals which are being received. (2) There is no need for an earth arrester gap in an aerial used only for transmitting, since its sole purpose is to provide the means by which the aerial can alternately be used for transmitting or receiving without a switch.

With regard to the questions which are unintelligible the reluctance of the core has nothing to do with the mutual inductance between two coils. The other question also cannot be answered, since the current in an inductance circuit never (theoretically) dies away to zero in a finite time when the applied voltage is removed from action. If you state that the current takes a tenth of a second to fall to a

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tenth or hundredth of its original value, the problem can be solved, but not if it falls to zero.

H. A. (Gibraltar).—Appointments to stations in Canada rest in the hands of Marconi's Wireless Telegraph Company of Canada, with whom you should communicate. They will be pleased to tell you whether they have any suitable vacancies. We cannot pass an opinion as to which is the better of the two branches you mention, but we certainly think that you would be more interested in the work of the R.N.A.S.

H. S. (Hackney).—We would advise you to apply to the nearest Naval recruiting office for the particulars you ask for. We cannot say what your prospects would be, as we have no knowledge of the qualifications you possess. We hope to have an article on this subject shortly.

C. W. A. (Eastwood).—There are a number of schools of wireless telegraphy advertising in THE WIRELESS WORLD at which you would be able to take a course of instruction. We would suggest that you look through the advertisements, and, on finding a school near you, write to them for particulars.

N. H. E. (Tiverton).—Many thanks for your letter. Yes, it would have been better if the lines had been marked as you say.

A. E. J. (Harringay).—To the best of our knowledge appointments such as you mention in your letter are very rarely given except to men actually experienced in wireless work. Thus, if you had had considerable experience as a commercial operator and were found suitable otherwise, you would stand a fairly good chance. Without practical knowledge we do not think you would be likely to obtain what you want. Write us again if this information is not sufficient.

S. E. T. (East Finchley) writes: (1) When sending Morse does one tap twice on the key for a dot and once for a dash or *vice versa*? (2) How does one indicate when each letter is finished? Is it by pausing, or by giving a prolonged dash, or by using the sign indicated in the Morse Code Card? How does one indicate when each word and sentence is finished?

Answer.—The Morse Code is sent by depressing the key for a short time for a dot and for a period three times as long for a dash. A short pause is given between each letter and a longer pause between each word. Full stops as shown on the Morse Card are frequently used to punctuate sentences, and, when necessary, other signs of punctuation, such as the comma, etc., are used.

CTE. DE LA B. (Paris) asks: (1) What is the maximum capacity of condensers ordinarily employed as aerial condensers? (2) What is the maximum capacity of those ordinarily employed for tuning the secondary circuit?

Answer.—(1) The aerial tuning condenser fitted to most of the Marconi Co.'s tuners has a maximum value of 10,000 centimetres and is variable from this value down to zero. (2) The value of the condenser across the inductance of the detector circuit depends on the form of detector used. Thus, with the magnetic detector operated by current and not potential, this condenser in the multiple tuner is of the same size as that in the aerial circuit, whilst in the case of the valve detector (potentially operated) the maximum value of the condenser is but a fraction of this. To calculate the capacity for use across the inductance in a detector circuit using a crystal it should be borne in mind that the maximum efficiency is obtained when the capacity across the inductance is reduced to zero. Further, the maximum wave-length to which it can be efficiently tuned will be about three times the value of its minimum wave-length. When, however, a low resistance crystal is used, a larger condenser is permissible. We trust that this will give you the information you require.

J. E. (Bergen, Norway).—The switch of which you sent us a diagram is interesting and would we think, work, but a much more efficient piece of apparatus could be designed. It would not do to use iron for contacts, for, amongst other reasons, this metal would soon become covered with a filament of oxide, which would act as a high resistance. You will find working out such designs very helpful.

G. M. (Birmingham).—We do not think there is now a school of wireless telegraphy nearer to you than Manchester.

T. V. H. (Smethwick).—See answer to last question. If this answer should catch the eye of any reader in Birmingham who would be willing to give lessons in wireless, will he kindly communicate with us? We most strongly recommend you to obtain the *Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, 3s. 10d. post free, as this will give you all the theoretical information you require and can readily be understood by anyone with a fair general education.

Will C. B. P. M., Delft, Holland, whose query was answered on page 532 of our issue for November last, kindly communicate with us, as we have the name and address of a correspondent in that town who would like to practise on a buzzer with him.

J. H. B. (B.E.F., France).—A knowledge of mathematics is very valuable in the study of wireless telegraphy, and to go deeply into its theory a very high degree of mathematical skill is required. However, a considerable theoretical knowledge and an excellent practical acquaintance with wireless can be acquired without any mathematical training, and, if the only portions of Hawkhead's book which you do not fully understand are those which require a mathematical knowledge, you should be fairly well advanced. For some time we have been publishing in our magazine a series of mathematical instructional articles, and these should be of considerable help to you. One of the

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best books we know for acquiring a good sound grounding in practical mathematics is that of Frank Castle, obtainable from our publishers. We can strongly recommend it to you.

A. C. (Deauville S-M.).—If the answers to your queries have not already appeared, they have not been received by us, and we would ask you kindly to repeat them, when they will receive immediate attention.

T. B. (Walker-on-Tyne).—There are no books on the subject of transmission of wireless waves through water. There is a method of signalling through water by sound waves, usually known as "Submarine Signalling," and recently a patent was taken out for the transmission of electric waves of extremely high frequency through water, but we do not think that any practical work has been done in this last direction.

X. Y. Z. (Portsmouth) says that he has several times been told (especially by one who is a seafaring man) that wireless operators become quite deaf after a period of three or four years' operating, owing to the electricity and the continual click of the telephones. This is utter nonsense and has not the slightest foundation in fact. The writer of this answer, who has had experience spreading over a number of years of wireless operating, has never yet heard of a case in which wireless operating caused deafness. Of course, if a man has bad ears the continual wearing of the telephones is likely to cause trouble, just as smoking is inadvisable for a man who has a bad throat, but for a man whose ears are healthy and hearing good the wearing of the telephones never causes any harm. This idea about operators becoming deaf is on a par with the statement that wireless waves cause neuralgia or blow up ships where they meet. We are glad to have this opportunity of dealing with the matter.

E. H. (Andover).—For particulars of wireless schools in London you should consult the advertisements in THE WIRELESS WORLD.

T. G. (Kingstown, Ireland) asks the following questions: (1) The power of the emergency set in watts and kilowatts and how to reckon it. (2) Why balls are used on the discharge rods, and why heating of same causes a faulty spark. (3) Why damping affects electricity. (4) Why the E.M.F. and current of an alternating current are at a maximum at different times. Questions 1, 3 and 4 indicate that our correspondent is not well acquainted with the principles of wireless telegraphy, and we would suggest that he procure a *Handbook of Technical Instruction for Wireless Telegraphists*, published by the Wireless Press at 3s. 10d. post free. With regard to question 2, balls are used on the discharge rod of the induction coil in emergency sets (we presume this is what our correspondent means) because an even spark is obtained in this way. Heating of the electrodes sometimes causes an arcing spark, which is bad, but this can be quickly put right. We do not think it necessary to give a full explanation on this point, as, from the other questions, we judge that our correspondent would not be able to understand it.

F. M. (Cahirciveen) also asks questions which show that he does not understand elementary principles. We would advise him to obtain Bangay's *Elementary Principles* and study it carefully, for until he understands the principles on which wireless work is based it would be useless for us to answer his question.

G. B. (Port Blair, India).—An aerial can respond to more than one wave-length, whether it be plain or with inductance or capacity in series, but the most important wave-length to which it responds is its fundamental.

If a diagram of the voltage distribution with a condenser in series be plotted for the aerial when oscillating at its fundamental wave-length, the general form of the curve will be as shown in Fig. 1.

When the condenser in series has a very small capacity the curve becomes like Fig. 2, which has a node of potential at the middle for the case where the capacity is zero. It is clearly impossible to obtain a smaller fundamental wave-length than this, which is equal to half the natural wave-length of the plain aerial.

The aerial can, however, respond to overtones, as shown by the voltage curve of Fig. 3, which represents the first overtone of the aerial with a condenser in series; or Fig. 4, which represents the second overtone.

Therefore to tune an aerial whose natural wave-length is 2,000 metres to 300 metres the capacity in series is adjusted till one of the

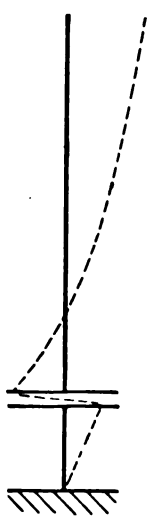

FIG. 1.

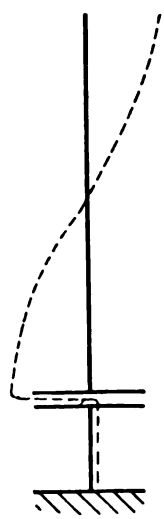

FIG. 2.

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FIG. 3.

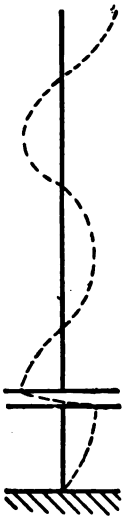

FIG. 4.

overtones of the aerial becomes 300 metres. It is impossible to make the fundamental wave-length so small as this, so that in this condition the aerial will respond strongly to at least one other wave-length besides 300 metres.

The amount of capacity required can be calculated from a formula given in Dr. Eccles's Handbook, page 123.

First calculate

$$\theta = \frac{\pi}{2}\frac{\lambda_0}{\lambda_1}$$

where λ_1 is the altered wave-length, λ_0 is the natural wave-length of the aerial. Then obtain the value of tan θ, where θ is expressed in radians. Then

$$\frac{\tan\theta}{\theta} = -\frac{C}{C_0}$$

where C is the capacity of the condenser and C_0 that of the aerial. The ratio $\frac{\tan\theta}{\theta}$ will have the same value for a number of values of θ, so that a given value of $\frac{C}{C_0}$ will tune the aerial to a number of wave-lengths.

In calculating the voltage to which a condenser is charged by means of a transformer it must be remembered that the transformer circuit is adjusted to be practically in resonance to the frequency of the alternating current supply. It can be shown that due to this the voltage to which the condenser is charged is $\frac{\pi}{2}E$, where E is the maximum value of the voltage of the transformer working on a non-resonating circuit such as a non-inductive load.

Since transformers are usually specified by the R.M.S. volts given under these conditions, and the R.M.S. volts are given by $\frac{E}{\sqrt{2}}$ the voltage to which the condenser is charged is given by $\frac{\pi}{2}\sqrt{2}r$ working voltage of transformer.

The factor $\sqrt{80}$ in your equation does not enter the above theoretical equation, and we do not know to what it refers, as you do not mention the book from which your formula is taken.

The transformer circuit is turned to resonance with the supply frequency by adding inductance to either the primary or secondary circuits of the transformer. Except in this sense, the inductance has no effect on the condenser voltage of such a circuit.

J. K. H. (Plymouth) asks for an explanation of the fact that (before the war) he was able to receive signals on 2,400 and 2,800 metres although his aerial was quite a small one, dimensions of the apparatus being given in the query.

We are not able to reproduce the details of your apparatus in these columns, and you have not stated the capacity of your primary condenser, nor do you state whether it was connected in series or parallel with the coil.

The two stations which you state you were able to receive are of considerable power, and therefore signals can be received although the arrangements used may not be the most efficient. The figures given in the text-book you mention are no doubt intended as the dimensions of apparatus to receive signals of the given wave-length in an efficient manner.

If your primary condenser be connected in parallel with the inductance a longer wave-length can be received with a given aerial than by using the coil without any condenser, although the signals are not quite so strong as if tuning is effected by means of inductance alone.

2. We are unable to give you any idea as to what further restrictions are likely to be put in force with regard to amateur stations after the war.

W. M. (Bradford).—French is by far the most useful language to know in the wireless profession. Spanish is a good second. Italian and Portuguese are also useful, and, judging by some of the magazines which have recently reached us from across the Atlantic, it will soon be necessary for everybody to learn a new language called American. By all means perfect your French and Spanish; you will find them most useful.

F. J. B. (B.E.F.).—The science of wireless is too young for us to be able to say the average number of years during which an operator is fit for service. It is a healthy occupation. The prospects of obtaining any other appointment in wireless after having served as an operator depend entirely upon the individual. Good men are continually being taken from the ranks of

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the operators to fill the positions of inspectors, instructors, etc., though naturally the number of such vacancies is not large compared with the number of operators. With regard to your third question regarding deafness, see our reply to X. Y. Z. (Portsmouth). In connection with your desire to transfer into a wireless section of the Army, we would suggest that you renew your application, pointing out that a similar application was sent in three months ago with the sanction of your officer.

J. J. M. (West Meath).—F. Castle's *Practical Mathematics* is just the book your brother requires, and if he studies this in conjunction with the other books you mention he should make excellent progress. He should not attempt more than a superficial study of the theory and calculation of electro-magnetic waves until he has obtained a thorough knowledge of mathematics. Write to us again if we can give you any further information.

D. J. D. (H.M.S. ——) inquires: (1) Whether in the formula for the power in a condenser circuit quoted in "Questions and Answers" for February, 1916, should not be

Power in watts $= \frac{1}{2} NCV^2$,

where N = frequency of discharge per second,
V = voltage of charged condenser,
C = capacity in farads.

The formula as stated above is correct, the capacity should be measured in farads, and not microfarads, as stated in our reply.

(2) The three formulas given in Mr. Hallborg's paper on "Low Frequency Resonance" are correct:

$$C^1 = (\text{Ratio})^2\, C^2.$$
$$L^2 = (\text{Ratio})^2\, L^1.$$
$$R^2 = (\text{Ratio})^2\, R^1.$$

The fact that the form of the equation for capacity is inverse to the other two can, as stated by Mr. Hallborg, be seen by reference to the vector diagrams of an ideal transformer, as given in text-books.

From these equations it follows that a large capacity in the primary (low voltage) circuit is equivalent to a small one in the secondary circuit, but the opposite holds for inductance and resistance.

The resistance of the circuit is not the high frequency resistance, since the circuit is a low frequency one, but it is the resistance of the circuit at the frequency of the current flowing through it—*i.e.*, of the alternator or other supply. This will be somewhat larger than the D.C. ohmic resistance.

J. W. (H.M.S. ——) asks: "Can a 10-inch coil be tuned to a 600 metre wave from a dynamo supplying 25 volts and connected direct?"

Answer.—This question is not at all clear. The tuning of a circuit has nothing to do with the supplied voltage of the coil charging it. If you will make your question clearer we will endeavour to answer it.

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A Radiotelegraphic Expedition to the Kara Sea

Report by the Engineer V. A. Tarasoff

In order to make it possible to establish regular voyages to the Kara Sea, it was first of all necessary to provide that sea with distinguishing beacons, to make measurements of the routes and to establish posts of observation for receiving information about the movements of the ice. It has taken three years for such a route to be established. Now maritime beacons have been set up and measurements have been carried out by the Chief Hydrographical Administration, whilst the Chief Administration of Posts and Telegraphs has erected three radiotelegraphic stations on the coast, which serve as observation posts for the movements of the ice-fields and for studying the climatic conditions.

We will not dilate further on the question of the equipment of these stations, but we should like to tell the reader the impressions which the author gathered from his voyage to the Kara littoral during the expedition in the year 1914. This voyage was undertaken with the object of ascertaining on the spot the required data for radio stations in the future, as the Kara radio stations are the first to be established under such exceptional conditions.

The radio stations had only just been erected, and it was necessary for them to be taken over by the State, to be supplied with all the necessaries for exploitation and to provide the staff with fuel, provisions and other articles of everyday necessity for the approaching winter.

As these stations are under the control of the Archangel Postal and Telegraph District, this Administration chartered two steamers for the expedition, the *Vassili Veliki* and *Nicolas II.*

Both vessels were placed at the disposal of the Administration on July 12th, 1914, and from this date the loading began. On the *Vassili Veliki* were loaded the provisions, exploitation material, kerosene, petrol, oil and various kinds of material for the work of erecting radio stations for the approaching winter, and the *Nicolas II* took on board in the main wood, coal and " briquettes."

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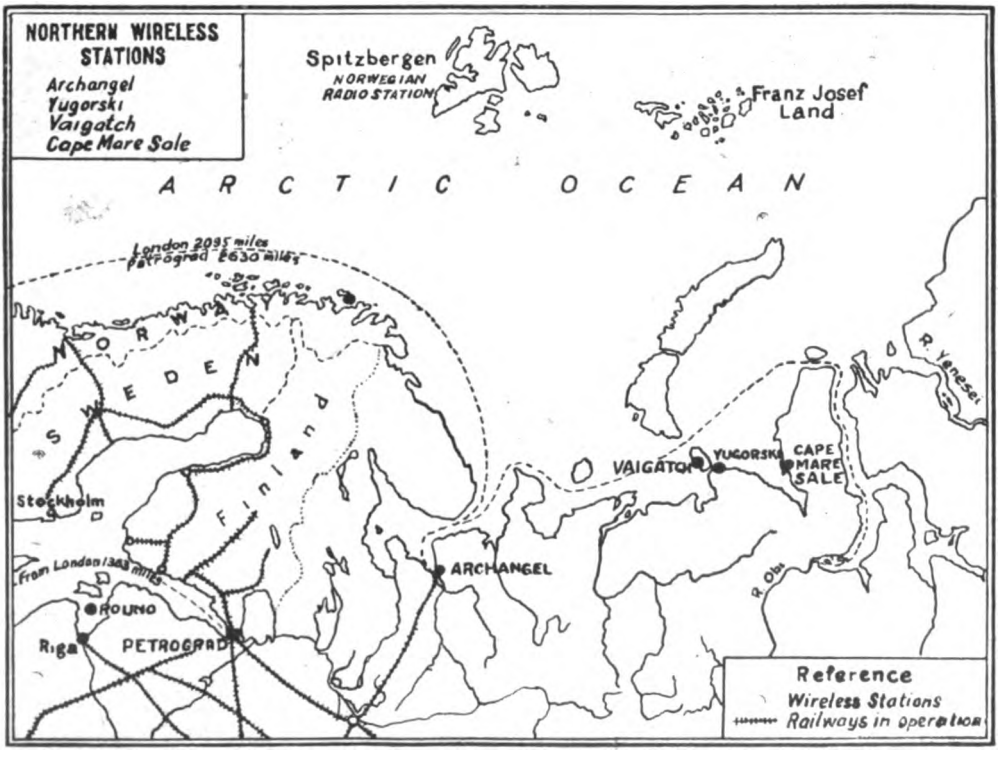
During the loading of the steamers the radiotelegraphic apparatus was erected upon the first of them, which was very appropriate in order to assure the greatest security for navigation among the ice.

On July 17th the loading of the *Vassili Veliki* was completed, the radio station was erected, and all was ready for sailing; while the *Nicolas II* was only to finish loading two days later. But time is money, and so is a time-charter of a steamer, and therefore it was decided not to wait till the *Nicolas II* had finished loading, but that the *Vassili Veliki* should sail during the night of July 18th, giving instructions to the remaining steamer to sail without delay as soon as loading was finished.

At 10 p.m. the steamer sailed away from the wharf, and the expedition started on its voyage. It was composed of the Chief of the Archangel Postal Telegraph District, the Chief Engineer and Engineer of the same district, the author, two members of the Archangel Hydro-meteorological Central Station, a physician, an assistant doctor, a student-electrician in the capacity of a practician, a student of medicine who had charge of the provisions, a person sent for geological research by the Academy of Sciences, three wireless officials, one for each of the Kara stations on the list, and about 60 labourers and artisans.

On the fourth day, away towards the horizon, the gloomy mass of the island of Vaigatch became visible ahead.

The steamer approached the Yugor Straits in the early morning. As the latter



SKETCH MAP SHOWING THE POSITION OF THE SIBERIAN WIRELESS STATIONS MENTIONED IN THIS ARTICLE

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ARCHANGEL—RUSSIA'S WHITE SEA PORT

was compactly covered with ice-fields, which were brought hither by the north-east wind from the Kara Sea, and the other straits (the Kara Strait lying 67 miles farther north than the Yugor Straits) were also in great part encumbered with ice, it was decided to enter Varenka Bay and to wait there till the straits should get clear.

At 7 o'clock in the morning the steamer entered the bay and anchored.

The expedition rested for about a day and a half, and probably would have remained in the bay still a little longer, as the straits were still closed by ice, but one circumstance forced us unexpectedly to get off hurriedly from the anchorage. On July 22nd (August 4th our style), at about 7 o'clock in the evening, we received a radio-telegram of the following tenor: "Germany declared war against Russia, German cruisers are in the White Sea, hide in the Kara Sea and notify this occurrence to the steamers of the Murman Company which are at the mouth of the River Petchora." Afterwards it turned out that a group of Norwegian commercial steamers, sailing not far from the Murman coast, were mistaken for German cruisers.

Everyone was certain that the "German cruisers" would not venture into the Kara Sea, where only dire necessity and exceptional circumstances could drive them; however, as war in general brings about a speeding up of life in any country, this compelled the expedition to economise time and involved special measures for carrying out the tasks which had been assumed by the expedition. The decision was taken to leave the anchorage at once, and to go through the straits to the radio station at Yugor Straits. The route to be covered was about 27 versts, but we had to overcome great difficulties among compact ice, endangering the safety of the steamer, especially its rudder and propellers. In the case of the large ice-blocks

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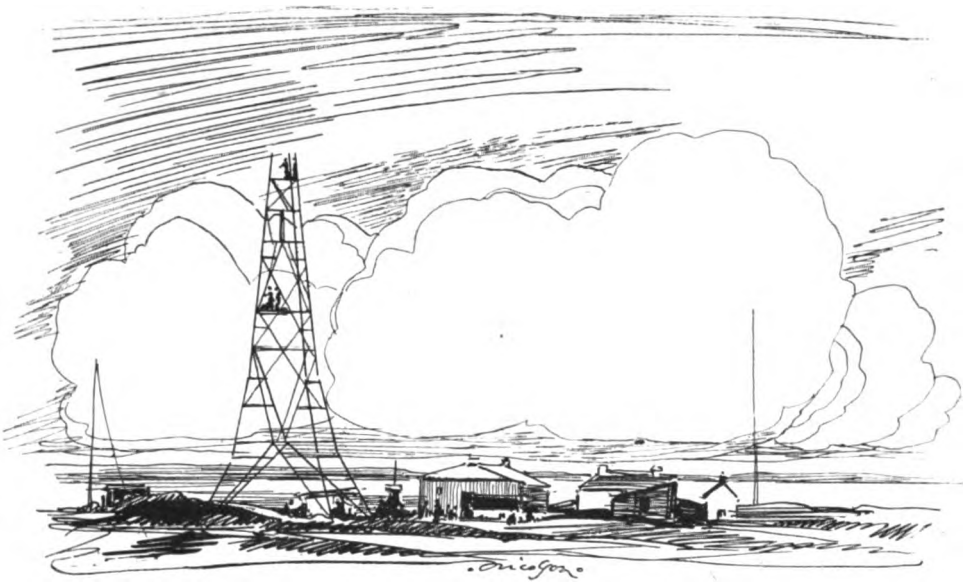

YUGORSKI STRAITS WIRELESS STATION—ERECTING THE MASTS

and the strong contrary currents we had to deal with in the straits, the fight was almost impossible. We moved on in the straits for about six hours and during this time we only reached the village of Khabaroff, *i.e.*, we advanced 10 miles. There remained 20 miles to the radio station in the Yugor Straits. On the bright golden morning sky it was already possible to distinguish the open-work outlines of the mast of the radio station. We dropped the anchor in order to await the beginning of the ebb tide and a change in the direction of the current in the straits. With the beginning of the ebb tide, at about 5 o'clock in the morning, the steamer began again to move forward, and after two hours we were near the Yugor Straits radio station at the anchorage, about 500 yards from the south shore of the straits.

There were six men on the station, four officials and two watchmen. The two latter were left here by the expedition of 1913. As regards the officials they were sent here in March, 1914, together with those who were appointed to Vaigatch, and they travelled the whole way from Archangel to the Yugor Straits by land, over the tundras through the Ust-Zilma. The men arrived at the Yugor Straits after a long journey which was rich in new impressions, and after a couple of days they entered into radio-telegraphic communication with Archangel. But two of them, who were appointed to attend to the Vaigatch radio station, continued their route to Vaigatch, where they arrived about a week later; and they also immediately entered into communication with the Yugor Straits, and through the latter with Archangel also.

After the arrivals of the officials at their posts, their life at first passed quietly; the new impressions of Polar scenery, hunting and excursions in snow-shoes filled up their free time. But they soon became accustomed to this and wearied of hunting

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and excursions, and a painful feeling of being cut off from the outer world and from people made itself felt. Echoes of these experiences reached Archangel through the radio-telegraph.

With respect to the buildings, they were found to be in a satisfactory condition. They are erected of hollow concrete blocks covered with corrugated iron ; the ceilings and floors are protected against freezing by layers of oil, moss, tarred paper and cork, and moreover the expedition has taken every care to make the buildings as far as possible suitable for wintering in the Polar cold.

The operations for the preparation of the buildings and the discharging of the steamer began at once after our arrival at the Yugor Straits. The discharging of the materials was the most important and the most difficult part of the work which awaited the Expedition. The sand banks and submerged rocks did not permit the vessel to approach the shore. The materials from the hold of the steamer had to be loaded on " Karbasses " (big boats capable of carrying a load up to about 5 tons), to be brought by them to the shore and then to be carried by the men to the station.

After three days discharging at Yugor Straits, and leaving a certain number of artisans on shore to carry out the work on the instructions given to them, the Expedition sailed for Vaigatch on July 24th, where it arrived the next morning and anchored in front of the Vaigatch radio station, which is situated on the Kara Straits.

At the place where the radio station is situated the coast of Vaigatch runs into the island and forms a sort of bay, which is bounded on the west by a group of small islands (Novossiltzeff, Voronoff), and from the east by the long island called Oleni. Here the water depth near the shore is greater ; the bottom is without submerged

" IN THE KARA SEA."

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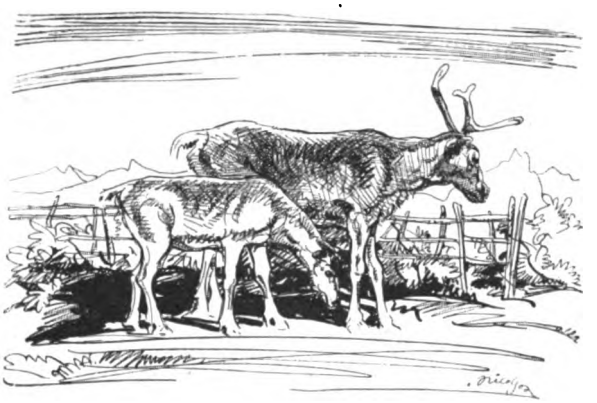

REINDEER. A CHARACTERISTIC FEATURE IN THESE NORTHERN LANDSCAPES

reefs, and therefore the steamer could approach to within a distance of 250 yards from the shore. This latter circumstance and the favourable weather enabled us to finish the discharging relatively quickly and easily. It took about two weeks to complete all this and also the work of preparing for the buildings.

On July 27th the second steamer of the Expedition, the *Nicolas II*, arrived with fuel. Its discharging proceeded simultaneously with that of the *Vassili Veliki*, and on July 30th was completed, whereupon the *Nicolas II* sailed on the same day to the Yugor Straits, passing through the Kara Sea, and on July 31st, after having completed all the work, the *Vassili Veliki* got off and sailed in the same direction.

After having travelled about 4 or 5 miles the Expedition noticed a ship coming the other way. This ship was the *Eclipse*, which was equipped by the Chief Hydrographical Administration for Polar navigation to search for the Expeditions of Lieutenant Brussiloff and the geologist Russanoff. The steamer was coming to meet us, for the purpose of receiving the radio-telegraphist who had been promised them to attend to their radio-telegraphic station. This latter was erected abroad, but the radio-telegraphist appointed by the firm for attending to the station turned out to belong to the reserve of the German Army, and he was put ashore in Norway, and the station remained unused. Meanwhile the Chief Hydrographical Administration attached great importance to this Expedition, and therefore urgently applied that one of the radio-telegraphists of the Kara stations should be put on board the *Eclipse*. Proceeding into the open sea, the *Vassili Veliki* soon stopped near the *Eclipse*, the radio-telegraphic station of which was quite in order, and, after having put on board the *Eclipse* the radio-telegraphist appointed to it, the *Vassili Veliki* continued her route.

On our return to Yugor Straits on August 1st we had to complete the work and the discharging of the fuel from the *Nicolas II*, awaiting favourable conditions which would make it possible to pass on to the Mare Sale (Salt Sea). The fact is that from the first days of our arrival in the Kara Sea we always received from Mare Sale the same discouraging reports: "In the sea, so far as the glass shows, there is compact broken ice; near the shore the water is clear for a short distance, the wind is north-east." This showed that the Mare Sale was blocked with ice and that the direction of the wind indicated that these conditions would not soon alter.

After many discussions and repeated examinations of the chart, a course was taken to the north, and the mast of the Mare Sale radio station soon became visible. We succeeded in reaching the spot at 10 o'clock in the evening, and anchored a short distance from the shore.

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The Mare Sale radio station is situated 135 miles south-east of the Yugor station, near Cape Mare Sale, and this is the most distant of all the Kara radio stations. The necessity of establishing a radio station at this place is explained by the following considerations. Ships which take the course from the western straits of the Kara Sea direct to the Island of Biely often meet compact impassable ice-fields on this route and are compelled to go round them along the south shores of the Kara Sea. Besides, it is often found in this part of the sea that the ice-fields travel to Yalmala and along towards the north. In such a case the Mare Sale radio station is very useful.

On Mare Sale the same operations were carried out as on the two other stations, only the discharging of the materials was more difficult and took more time. This was caused by the shallow water near the shore, which did not allow the loaded boats to approach very near, and by the steep ascent to the station.

On August 21st the work on Mare Sale was finished, and at 3 o'clock in the night of the 22nd the expedition sailed to Yugor Straits. During this passage we did not see a single ice-field, and the voyage was completed in 13 hours exactly.

The 22nd, 23rd, and 24th August were spent in finishing the work on the Yugor Straits.

All that was necessary had already been discharged on shore ; it only remained to bring it to the station, but even this became extraordinarily difficult, owing to a storm.

We succeeded in the main in finishing all the work at the Yugor Straits also. Having spent August 25th in Varneka Bay, in order to take in a supply of coal from the steamer *Nicolas II.*, the expedition left the anchorage on the 25th and sailed to Archangel, where we arrived on August 29th at 6 o'clock in the evening.

At present the following persons remain on the Kara stations :—At the Yugor Straits—a manager acting as chief engineer, a radio-telegraphist of the third class, a medical assistant, two watchmen and one labourer ; at the Vaigatch—a radio-telegraphist of third class, two fourth-class radio-telegraphists and two watchmen ; at Mare Sale—one third-class and one fourth-class radio-telegraphist and two watchmen. In addition a clergyman-missionary was allowed to settle down for the winter at the radio station at Vaigatch, whose mission was to convert the Samoyedes to the Greek-Catholic religion.

The Ministry have taken all the necessary measures to make the life of the staff at the radio station as comfortable as possible. Paying special attention to the question of the supplies of food for the officials, the Ministry have provided the radio stations with the most various provisions, which were

NANSEN, OF POLAR EXPLORATION FAME.

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selected in conformity with local conditions on instructions of Archangel physicians. For Yugor Straits and Vaigatch provisions for 14 months were prepared and for the Mare Sale, where perhaps it may not be possible to get in every year, provisions were stored for 28 months. All these provisions are placed at the disposal of the managers of the radio stations, with special instructions for their preservation and consumption.

Bearing in mind the experience of 1913, when the officials, although they had sufficient provisions, nevertheless experienced difficulties because they were not able to use them skilfully, one special man was left this year at each of the radio stations—a second watchman—a person who was at the same time able to prepare all sorts of meals properly. Besides, advances were made to the officials for purchases of fresh deer-meat, when this might be possible at the beginning of the spring and on the arrival of the Samoyedes at these places. Finally, for the same reasons, in order to make the absence of fresh meat less hard, the officials and watchmen were supplied with arms and a sufficient quantity of ammunition for hunting wild fowl, which appear here in the spring in great abundance.

THE COMMANDER OF THE EXPEDITION—CAPTAIN SVERDRUP.

For the purpose of giving medical aid a trained hospital assistant was left on the Yugor station, who had also, in case of necessity, to visit the Vaigatch radio station. In addition all the stations are supplied with pharmaceutical stores containing a sufficient quantity of medicaments and popular text-books on medicine, and in serious cases the use of the radiotelegraph for communication with Archangel physicians is allowed to all free of charge.

In order to give the officials and watchmen the possibility of using their free time to best advantage, all the radio stations are provided with reading-rooms and with draughts and chess. Finally, for the purpose of fighting against somnolence and apathy, which are so undesirable here, special attention is paid to sport and music. Everybody was supplied for sport with snow-shoes, toboggans, guns, traps for catching arctic foxes, and lathes for metal work. By way of musical instruments, each radio station is provided with a gramophone with 50 records, a guitar, a mandoline and a balalaika (a Russian popular musical instrument—a sort of three-stringed guitar).

The Ministry of Posts and Telegraphs have done from their side all that it was possible to do for the staff of the Kara radio stations, and this gives one good reason to expect that the wintering of the officials on the radio stations will be without any complications. In everything the beginning is hard; in future it will be easier.

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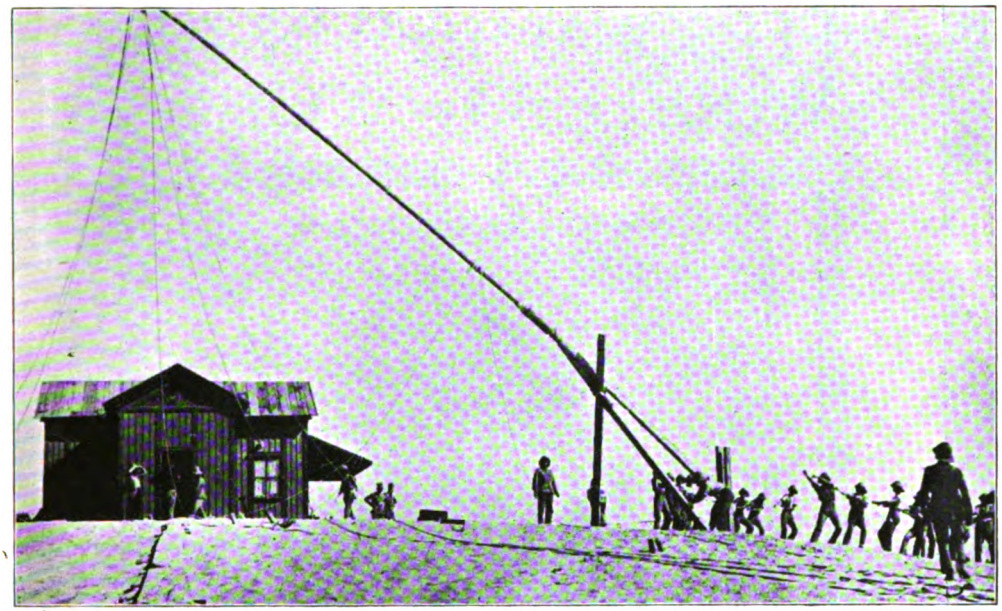
With the British Forces at the Suez Canal



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THE TOP PICTURE DEPICTS THE HOISTING OF AN AERIAL OF A FIELD WIRELESS TELEGRAPH STATION, WHILST THE LOWER ONE SHOWS THE ELECTRICAL CONNECTIONS BEING MADE.

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PERSONALITIES IN THE WIRELESS WORLD

MR. AUGUST COLLETTE,

Chief Engineer, Netherlands State Telegraphs.

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THE Chief Engineer of the Netherlands State Telegraphs, August Everhard Rudolf Collette, was born on June 25th, 1857, at Maastricht, and studied for the profession of civil engineer at the Polytechnic School at Delft, where he graduated in 1882. He finished his studies as an electrician at the Polytechnic School at Dresden.

Practically ever since the Public Telegraph Service has been established in the Netherlands by the Government, the name Collette stands out amongst those of the leading personalities. Mr. Collette joined the staff of the Netherlands State Telegraphs in 1880, and was appointed Governmental Telegraph Engineer for special service in 1893. He succeeded his father, who retired in 1899, as Engineer-in-Chief of the Netherlands Telegraphs and Telephones, and as General Manager of the Technical Service. In the thirty-six years during which Mr. Collette has been intimately associated with the development of telegraphy and telephony in his native country vast progress has been made, and to him belongs most of the credit for this advance.

Wireless telegraphy has from the very first claimed his special attention. This was evident from the various trials carried out in the '90's, and from the very interesting lectures delivered by him on this subject. Mr. Collette is a member of the Permanent Commission for Wireless Telegraphs, the advice of which institution is always sought on the many important questions relating to wireless telegraphy. As a proof of the great influence exercised by the present Chief Engineer, it may be mentioned that he was appointed by Royal Letters Patent of June 1st, 1911, member of a committee of four to draw up plans for revising the working of the telegraph and telephone systems in the Dutch East Indies, and to report to the Dutch East Indian Government on the subject. With this end in view he made a comprehensive voyage all over the Dutch East Indies, and brought out a report to his Government which had a marked influence on the reorganisation of the telegraph and telephone service of this colony.

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The Disc Discharger

By W. H. NOTTAGE, B.Sc.

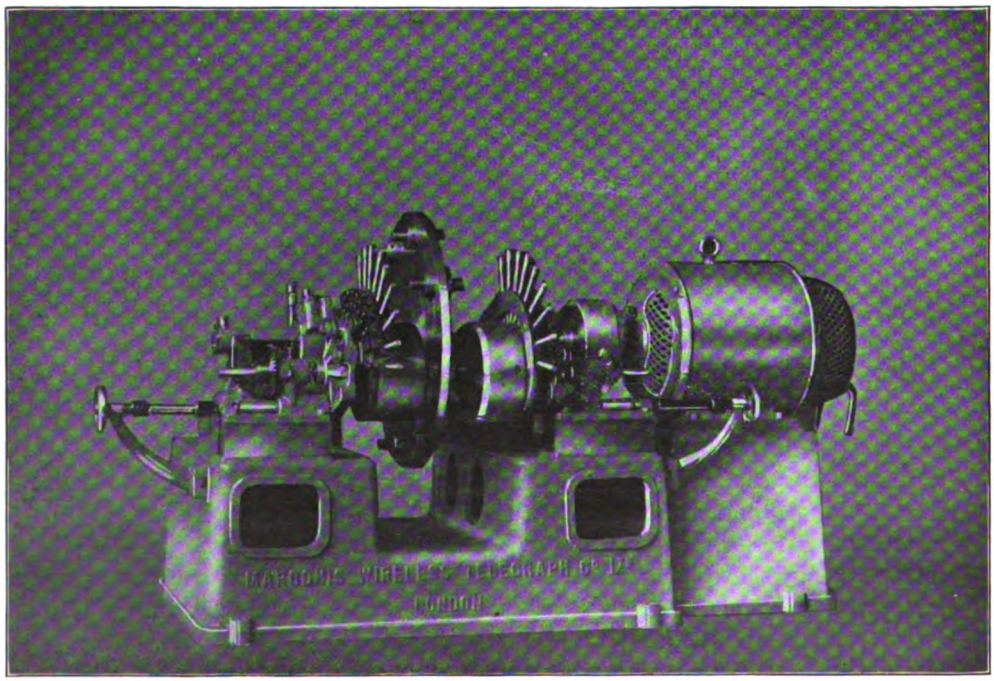
THE discharger, or spark-gap, of an oscillatory circuit has to perform the following functions :—

1. Allow the condenser of the circuit to be charged to a high voltage from the source of energy (induction coil, alternating current transformer or high tension battery), and when charged,

2. Allow it to discharge through the high frequency circuit of which the resistance, including that of the gap, must be low in order that the discharge may be an oscillatory one and as small a percentage of energy as possible may be lost by the resistance.

3. When the oscillatory discharge has ceased the gap must be in a condition to allow the condenser again to be charged.

Any discharger which fulfils the above functions will be sufficient for the production of oscillations in the circuit, but it is, for successful commercial telegraphy, necessary for the gap, in addition, to cause the charge and discharge to take place at uniform intervals of time. For best working the voltage to which the condenser is charged should be the same for each spark. There is some advantage if the discharger is capable of extinguishing the spark in the primary circuit as soon as



DISC DISCHARGER FOR 75 K.W. INSTALLATION.

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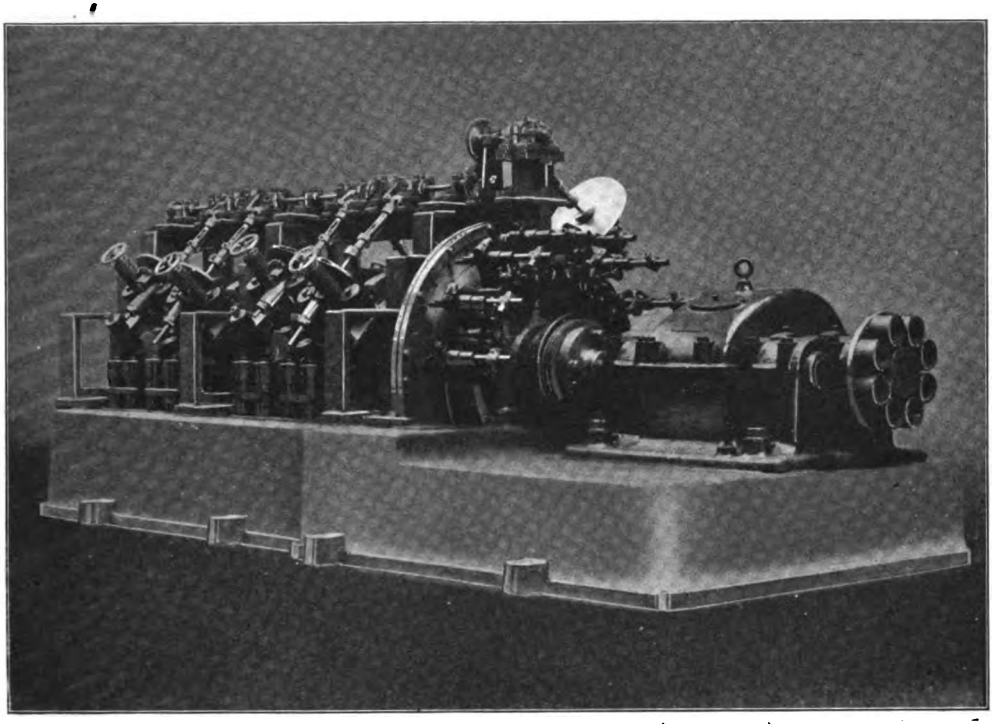

CONTINUOUS WAVE DISC DISCHARGER (100 K.W.).

the maximum amount of energy has been transferred from it to the secondary or aerial circuit, as this will prevent the energy surging back again into the primary circuit. In the case of the ordinary fixed gap discharger the voltage to which the condenser is first charged rises to a certain value depending on the length of the gap. Up to this point the air in between the electrodes is a good insulator, so that no current flows across the gap. When this voltage is reached the air is unable to withstand the electric stresses set up and a spark passes between the electrodes. This spark ionizes the air, and also carries some metallic vapour from the electrodes into the gap, with the result that it becomes a good conductor, the resistance being very small, so that the condenser discharges in an oscillatory manner. After a time the discharge will stop, due to the fact that most of the energy stored up in the charged condenser has been used up in various ways. If the air in the gap were now to revert to its original condition before the discharge took place, then the whole process would be repeated regularly. But the ionization of the air persists to a certain extent, and therefore the condenser will become charged to a lower voltage than in the first case before the discharge takes place, and after the discharge the amount of ignition of the air in the gap will differ from the amount at the end of the first discharge, so that the third discharge will probably be at a different voltage still.

The interval of time between the discharges depends on the time taken for the condenser to charge up to the discharging voltage, and is therefore seen to be variable. The sound of the spark will not be a musical note, since this requires the sparks to take place at equal time-intervals. The energy from the aerial will be radiated at the same

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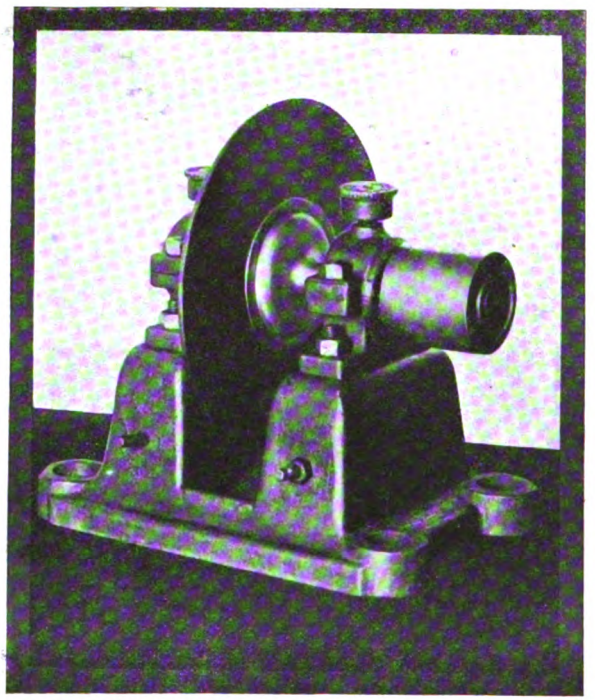
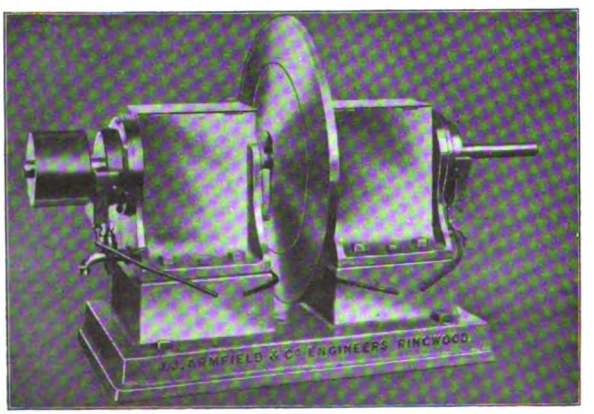


THE FIRST DISC DISCHARGER EVER MADE. THIS WAS USED IN EARLY EXPERIMENTS AT POLDHU.

intervals as the spark in the primary circuit, and therefore the note at the receiving station telephone will not be a musical one. If the electrodes of the sparkgap be set at a distance too great for the maximum voltage given by the generator to cause a spark, then no discharge can take place unless the voltage at the condenser plates rises, by resonance, to a value sufficient to cause a spark. Several alternations of the supply are necessary before this can take place so that the sparks will take place at long intervals. If, on the other hand, the gap be set at a distance much shorter than required by the maximum voltage, then there may be more than one spark per alternation, but in most cases the charging current will arc across the electrodes so that the condenser does not become charged at all, These effects contribute to making the discharge take place at irregular intervals. Now consider the action of the disc discharger. This consists of two fixed electrodes and a rotating disc provided with spokes or studs. It is so arranged that in a certain position two studs come opposite the two fixed electrodes, thus forming two short spark gaps in series. In all other relative positions the gaps between disc and electrodes are very much longer, so that no discharge can take place in these positions. The disc is provided, in the most usual case, with two studs for each pole of the alternator of the set. It is also mounted, suitably insulated, on an extension of the shaft of the alternator. In this case there will be one discharge for each alternation of the current supplied by the alternator, and, since the disc rotates in synchronism with it, the discharge takes



ANOTHER FORM OF SMOOTH DISC OF LATER DATE. THE BEARINGS RUN IN OIL IN THIS TYPE.

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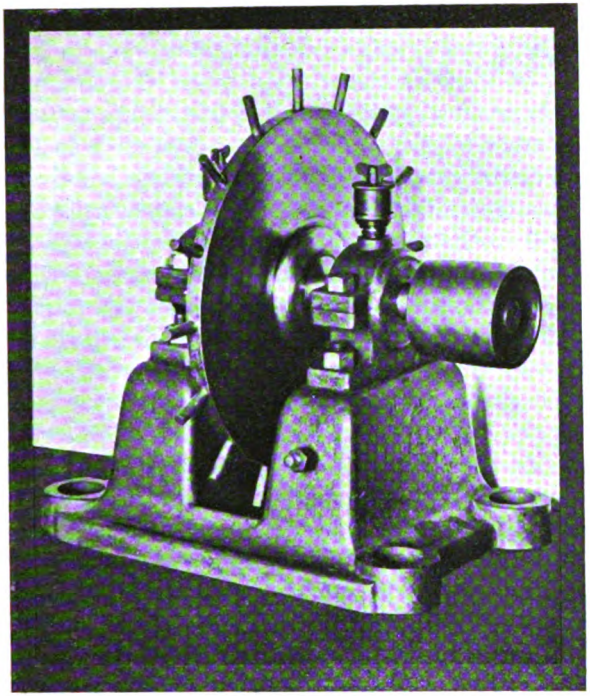
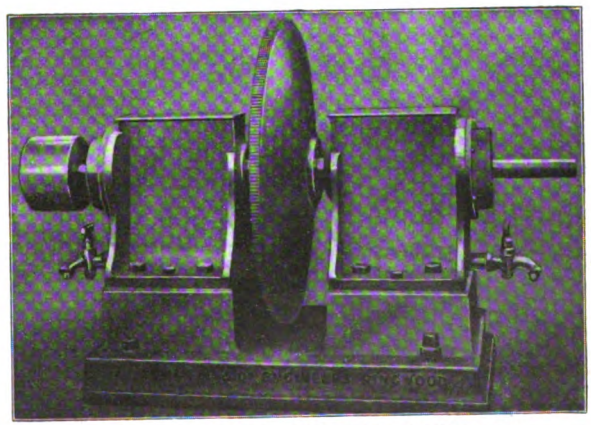


THE FIRST DISC DISCHARGER WITH RADIAL TEETH.

place always at the same point of the E.M.F. curve of the condenser charging current, so that the voltage, and hence the energy in the condenser, is always the same at the discharge, being independent of the length of the gap, which may be made quite small, it only being necessary to allow sufficient clearance between the studs and electrodes to prevent them touching when heated by the spark. Therefore, although there are two gaps in series, the total resistance is less than that of an equivalent fixed gap.

As the studs and electrodes separate the resistance of the gap rises rapidly, since not only is its length increased, but the air is not ionized in the extra path, so that the spark is extinguished in a definite time. If an arc of the low frequency circuit should strike across the electrodes it will quickly be drawn out and extinguished, the process being assisted by the draught created by the moving studs, which also helps to keep them cool. When the wave-length is long, as is the case for high-power stations, the spark may be extinguished after only a few oscillations of the primary circuit, with the result that the surging-back of energy from the secondary circuit is prevented. The frequency of the spark has a great influence on the ease with which the resulting signals can be received if, as is usual, a telephone method of reception is in use. A note given by a discharge of from 400 to 800 sparks per second is found to be the best for most purposes, since the ear is very sensitive to this range of frequency, without becoming so fatigued as when a higher pitch is used. Hence alternators giving from 200 to 400 cycles per second are the most suitable for wireless telegraphic purposes.



AN EARLY TOOTHED DISC DISCHARGER WITH BEARINGS RUNNING IN OIL.

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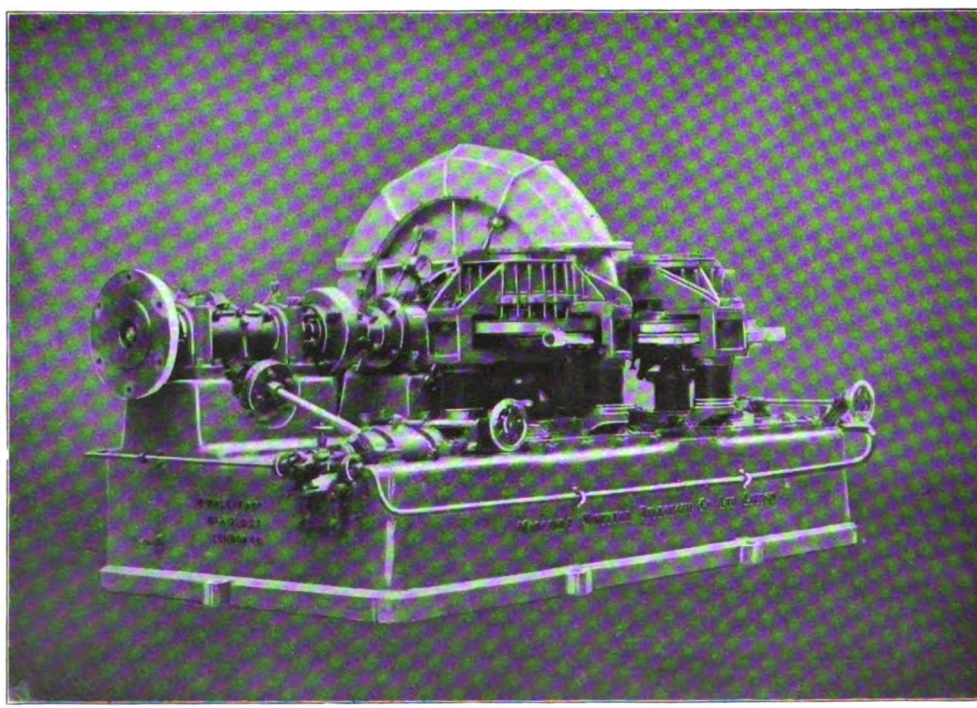
In small installations, such as those used on board ships, it is usual to use an alternator of lower frequency to charge the circuit. Such machines are cheaper and require less attention to run than those of higher frequencies. To obtain a higher spark-note than would be given by one spark per half-cycle the disc may be provided with a sufficient number of studs to give two or three or even more sparks per half-cycle. The note given by a discharger which gives one spark per half-cycle is, when the set is properly adjusted, a pure musical note. In this case every spark occurs when the condenser is charged to the same voltage, and hence the energy given to the aerial and by that radiated into space is the same in all cases. When two sparks per half-cycle occur the conditions may be adjusted so that the voltage is the same for each, but when more than two occur the voltage will in general be different. When there are five or six studs the voltage may be insufficient to break down the gap for one position. Due to these facts, the note in this case is not so pure a musical tone as for the one spark per half-cycle, but it is immensely superior to the fixed gap spark for audibility. In constructing the disc discharger the fixed electrodes are often made in the form of discs which can rotate slowly so that the wear of metal caused by the spark may be spread out over a larger surface, thus reducing the alteration in length of the gap which occurs during an extended run. They are carried on a fitting by which they may be shifted round in position so as to cause the spark to occur at the precise point on the E.M.F. curve of the condenser charging current, which gives best results.



A MODERN 300 K.W. DISC DISCHARGER

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Digest of Wireless Literature

Terrestrial Magnetism.

In introducing his " Kelvin Lecture " on " Terrestrial Magnetism " at the fifth ordinary general meeting of the current session of the Scottish Local Section of the Institution of Electrical Engineers, held recently in the rooms, 207, Bath Street, Glasgow, Dr. Charles Chree, F.R.S., made interesting references to the work of Scottish scientific investigators in this particular field. The scientists to whom he referred were Scottish, but the majority of them carried on their investigations elsewhere, and some of them were so successful in their work that their discoveries remain as landmarks in the development of terrestrial magnetism. In his lecture proper Dr. Chree dealt at length with the relation of Lord Kelvin to terrestrial magnetism. One of the objects of his lecture, he said, was to make clear the dependence of the practical man upon the scientific observer. Referring to magnetic storms, he pointed out that Lord Kelvin had called attention to the difficulties in the way of accepting any direct magnetic action between the sun and the earth, and expressed the opinion that Lord Kelvin did useful service in calling attention to the question of the expenditure of energy in magnetic storms. In his lecture Dr. Chree confined himself, however, to three of the outstanding problems enumerated by Lord Kelvin—the secular change, the solar diurnal variation, and the phenomena of magnetic disturbance—concluding with references to the recent notable work of Professor Birkeland and Stormer of Norway, Professor E. Hale, and Dr. L. A. Bauer. On the question whether terrestrial magnetism had any direct bearing on the problems of electrical engineering, he said that if wireless phenomena were affected—as had been suggested—by the greater or less conductivity of the upper atmosphere, one would expect them to have certain features in common with magnetic phenomena. In particular the 11-year period and the 27-day period might be expected to disclose themselves. If these periods affected wireless to anything like the extent to which they affected terrestrial magnetism there should be no great difficulty in establishing the fact if systematic observations were taken to that end. Another possibility was that means might be developed for utilising some of the power that now went to magnetic storms. This would, naturally, be most feasible in high latitudes, where aurora and magnetic disturbances were most in evidence.—(*Glasgow Herald report.*)

* * * * * *

Atmospheric Electrical Variations at Sunrise and Sunset.

Among the papers read recently before the Royal Society there was a paper on the above subject by Mr. E. H. Nichols. Observations were made for a period of fifteen minutes before and fifteen minutes after both sunrise and sunset, using the Wilson compensating gold-leaf electroscope for conductivity and earth-air current, and two Ebert electrometers for measuring the positive and negative electric charges. The results show a decided uniform decrease in the value of the electrical quantities throughout the sunset period, but the solar effect at sunrise is not at all pronounced. The potential curves for Kew Observatory were analysed for the years 1912 and

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1914 for the 30-minute period at sunrise and sunset, and monthly means obtained for 5-minute intervals, these being corrected for diurnal variation. There is a general increase in the potential at both sunrise and sunset, being more noticeable in the winter months, but there is no evidence of any sudden change. It is possible that the electrical variations observed may be of assistance in elucidating the problems of wireless transmission.—(*Electrician.*)

* * * * * *

RADIUM AND AERIALS.

The following abstract of an article by E. Leimer in the *Elektrotechnische Zeitschrift*, printed recently by the *Electrician*, will be of special interest to our readers as it contains a report of some experiments on new lines.

On the results of Szilard with radium-coated lightning conductors becoming known to the author he was led to consider the possibility that radium might exert some effect upon the reception of radio-telegraphic signals. The first tentative experiments seemed to give evidence of positive effects ; but as the author was obliged to discontinue them in consequence of the war he now publishes his results with a view to stimulating further research and also obtaining independent confirmation of his own conclusions.

The first experiments were made with an indoor antenna consisting of a wood rod closely wound throughout its length with wire, the rod being directed towards a sending station, FL, about 300 km. distant from it. This antenna was suspended in a room. The receiving set used comprised a galena detector, 4,000 ohm telephones, and a tuning coil 50 mm. in diameter, and having 800 turns of enamelled wire. No signals were audible from FL at any position on the tuning coil. Signals were, however, at once distinctly audible as soon as a sealed glass tube containing radium bromide of 50,000 units (and thus very weak) was brought near. The signals vanished when the shunt resistance was 220 ohms, using the shunted telephone method. The tuning was not at all sharp, and showed no maximum for any length of included wire between 80 and 120 metres. A change in the position of the radium did not produce any noticeable differences ; but the orientation had a marked effect. At angles greater than $\pm$ 30 deg. the reception ceased entirely.

Encouraged by these results, the author continued his investigations in order to determine the effect of radium on ordinary antennæ. The antenna consisted of two parallel 1.5 mm. phosphor-bronze wires held 1 metre apart and 8 metres above the ground, directed towards the station FL, as was also the connection to the receiving set. For this latter the same tuning coil was employed ; but an electrolytic replaced the galena detector, and in place of the telephones a special moving-coil mirror galvanometer, of 500 ohms resistance and period two seconds, was used. The signals utilised were the 10-second time signals from FL. With the best tuning and 56 metres the telephones gave 80 ohms for silence ; the galvanometer showed 20–21 microamperes. With the antenna disconnected the current through the detector was 0.7 microampere. On the radium tube being brought near to the free end of the antenna the galvanometer reading was 50–53 microamperes ; to reach this maximum the tuner had to be shifted from 56 to 48 metres. In this position the reception without radium was quite as mistuned as it was in the 56 metres position with radium. When the radium was fastened at the mid-point of the antenna no

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reception was possible, even with the telephones. With the radium arranged at the connected end of the antenna the current through the detector increased to 35–38 microamperes at the 40-metre tuner position. All the results have been definitely confirmed as a result of numerous control experiments, made under conditions as nearly similar as possible.

These experiments show that by suitably bringing up radium in proximity to the antenna the vibration image of the latter is changed in the direction of an apparent shortening of the wave; further, that a considerable increase in signal strength, as measured in the detector circuit, is occasioned by the proximity of radium, which must in any case be caused by a higher received primary current.

The proximity of radium to the tuning coil itself has, however, the effect of rendering distinctly worse the previously distinct telephonic reception, without it being possible to discern any definite mistuning, and this applies whether the radium tube be insulated or earthed. On the other hand, the radium tube has no noticeable effect on any of the other parts of the receiving equipment.

* * * * * *

A Wireless-Controlled Torpedo and Boat.

From time to time paragraphs have appeared in the English papers regarding the Wireless Controlled Torpedo and Boat of Mr. John Hays Hammond, Jun.. a young American inventor. In an article describing this invention, the *Wireless Age* says that, as already reported, the invention has so conclusively demonstrated its efficiency as a destructive agency that the United States Government is preparing to buy the patent and to proceed with installations for coast defence. The Fortifications Bill carries an initial appropriation of $1,167,000. The inventor wants his own Government to have the benefit of his device on terms that are pronounced most reasonable. England, it is said, is willing to pay $10,000,000 instantly for it.

There is one condition attached to the acquirement of the patent rights by the U.S. Government. The torpedo must demonstrate its value before a joint Army and Navy Board.

The virtue of the wireless dynamic torpedo is explained by Mr. Hammond to be that you can take a charge of explosives or a projectile and deliver it at the target under constant control from the shore.

The torpedo, as described by Mr. Hammond, is at present of two types—one to be used above water, travelling at 50 miles an hour, and the other a submerged type, except for a short wireless mast virtually immune from gun fire, with a speed of 28 miles an hour. The surface type is a new sort of craft, called by naval experts the "sea sled." They can be made of any size desirable for the purpose in view and travel so fast as to be safe from destructive gunshot.

The experiments at Gloucester have been made with a 30-ton boat. The inventions do not cover any special type of boat, but the patents relate wholly to control and to the method of firing torpedoes from these carriers. The boat can be controlled just as easily for most purposes from an aeroplane or warship as from a shore station.

Here is a summary of some of the features of the invention, according to description:—

It can be steered by wireless in any direction.

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Its engines (two 500 horse-power gasoline motors) can be started, stopped and controlled at various speeds by wireless.

It can carry a ton of high explosive.

It is more accurate, in the opinion of army experts, than the fire of big guns.

It can be operated against an enemy by a single man, who remains ashore, or on a warship, or in an aeroplane, and whose sole instruments are a telescope and an electric key.

It cannot be interfered with by adverse wireless waves because it is controlled by a system of selective transmission.

If the wave-length controlling it is discovered by an enemy, that wave-length can be changed while the torpedo is in sight.

If an enemy attempts to interfere with it by wireless, it possesses the faculty of pointing immediately in the direction of that enemy and making directly for him.

It can be operated at night as well as by day, subject to accurate control by an arrangement of tiny lights, so shielded as to be visible only to the operator. It carries a searchlight of its own, which may be turned on and off by wireless.

The surface type will cost about $47,500 each.

The submarine type will cost about $9,000 each.

The surface type has a cruising radius of 200 miles, at 50 miles an hour.

It can be guided 200 miles to sea by an aeroplane and launched against an enemy at the end of the run.

The surface type has a capacity of double attack. It carries a torpedo which, when the destroyer is in striking distance, can be launched by wireless. If the torpedo strikes, the destroyer can be turned around by wireless and sent home. If the torpedo misses, the destroyer, which carries an additional half-ton of explosive, can be sent on to retrieve the error, in which case, of course, it is itself destroyed upon impact.

The terms upon which Mr. Hammond offers to sell his invention exclusively to the United States are these, proposed to the War Department in a letter :—

He will assign all patents to the United States Government for the sum of $530,000, plus 10 per cent. of the cost of installing each radio station, whether ashore or aboat, plus $10,000 royalty for each destroyer built. This is based on an order of not less than three units, a unit consisting of one station and ten destroyers. If the Government builds only two units, the lump sum is to be $630,000. If it builds only one unit, the lump sum is to be $730,000.

In addition, Mr. Hammond will give his time and his services to the Government in installing and developing the system, so long as the War Department wants him. As an alternative proposition, in case the Government does not want the exclusive rights, Mr. Hammond will sell the manufacturing rights for the United States alone for $350,000.

THE WIRELESS WORLD is a little sceptical regarding the claims of this invention, and, after all, at the time of writing Mr. Hammond has not yet disposed of his rights to the United States Government. The capture of a single wireless controlled vessel of this type which had failed to explode might place in the hands of the enemy the whole secret and enable them to devise protective measures quite sufficient to make the boats useless for further warfare.

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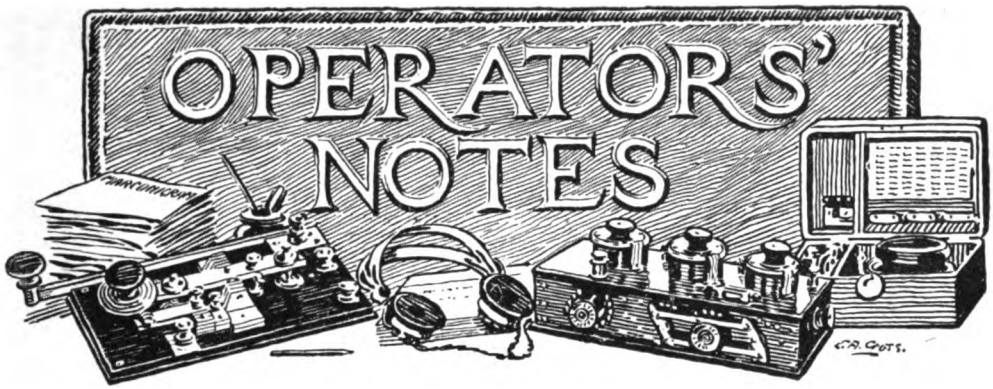

Using the Multiple Tuner.

Although every Marconi ship installation contains a multiple tuner, either with or without an intermediate circuit, it is surprising how few men make the best use of the facilities offered by this instrument. It is true, of course, that in many cases just as good results can be obtained on the " stand-bi " side as on " tune," but on the other hand cases frequently arise in which the " tune " side is of the greatest assistance for comfortable working.

There are five main ways in which going on to " tuned " side helps the operator. They are as follows :—

(1) By eliminating or reducing jambing.
(2) By eliminating or reducing atmospherics.
(3) By cutting out noises and interference from the converter or ship's mains.
(4) By reducing the strength of signals when these are inconveniently loud.
(5) By at times increasing the strength of signals.

In these times, when a large number of warships are on active service using their wireless frequently and on a number of different wavelengths, the value of tuning to eliminate interference is most marked. In crowded waters and at a distance of two or three miles a powerful naval installation even on a very long wavelength may cause interference to a merchant vessel, although a little farther off it would not be heard. Of course, most interference is caused by other merchant vessels and coast stations working on the usual 600-metre wave, but even in these cases advantage is sometimes found in tuning, as a slight difference in wavelength will often allow one ship to be picked out more strongly than others.

The ever-present trouble arising from atmospheric disturbances can in many cases be largely reduced by going on the " tune " side, particularly with certain types of atmospherics. In many cases, however, " X's " come in equally as strong on " tuned " side as " stand-bi," but the change is always worth trying. Where the signals are strong the operator can afford to reduce the coupling considerably, and this always gives some improvement.

On some ships, particularly at night, where the dynamo in the engine-room is mismanaged and there is much sparking at the commutator, the operator is liable to hear continual humming noises in the telephones due to induction from the ship's mains. There are cases too where the converter in the silence cabin sets up similar

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interference. In both of these cases great improvement will be found by working on the " tune " side, and we have known ships where the trouble is entirely removed in this way.

The point not always considered by new men, but well known to the more experienced operators, is that very loud signals from installations close at hand are most difficult to read, particularly with the magnetic detector. Our experience has been that far more comfortable working is obtained by tuning on very weak coupling, and we would counsel those who have not tried this method to give it a test.

With regard to the fifth advantage given above, it has been found that some signals come in much louder and better on the " tuned " side than on " stand-bi," particularly in the case of quenched sparks. There are theoretical reasons for this which we cannot enter into in this article. Here again we would suggest that the operator make tests for himself. In all cases it is well to keep a list of stations which come in best on " tune " side and the adjustments of the various circuits which give best results. This last will, of course, be useless for anything but the particular tuner, magnetic detector and aerial in use at the time. If a new aerial is erected or a new primary fitted to the magnetic detector, new observations will have to be made.

An occasional source of trouble and one to be carefully watched is the micrometer gap. This should be adjusted in the way that the student is taught in the Marconi School, and should on no account be opened too wide. We have found many operators who think that if sparking is occurring in the gap something is wrong with this adjustment, and they accordingly widen the space until the sparking ceases. By doing this they are endangering the tuner, for the pressure which with the small gap broke down the air space and caused the spark to earth will now be exerted on the dielectrics of the condensers and will tend to puncture them. When there seems to be excessive sparking in the micrometer gap, the main arrester gap should be inspected to see whether the space between the plates is too large. This sometimes happens when the central nut becomes loosened.

It should not be forgotten that the multiple tuner can be used as a wavemeter both for incoming waves and as a means of adjusting the transmitter after a breakdown has been repaired. For this last purpose the aerial and earth leads are removed and the A. and E. terminal connected by a loop of stiff wire. The tuner and magnetic detector should then be removed to some place out of sound of the spark and best signals obtained on the " tune " side in the ordinary way. The intensifier handle should be set at a reading not higher than 10 per cent., and the wavelength of the transmitting circuit can then be ascertained in the usual way, from the table of wavelengths supplied with each tuner.

Operators using valve or crystal receivers for the first time should lose no time in becoming acquainted with the extremely sharp tuning made possible by these instruments. Very little appreciable difference in strength of signals is noticeable on reducing the coupling from 90° to 30°, or even 20° ; but, of course, at these low readings very slight alterations of the condenser adjustments will cause the signals to disappear. In some cases louder signals are obtained on a fairly loose than on a tight coupling, and in almost all cases signals come in better on " tune " than on " stdbi."

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Dr. Hay's "Continuous Current Engineering." *

Reviewed by PROFESSOR E. W. MARCHANT, D.Sc.

THE progress of electrical engineering has led to the production of many books which profess to teach it; the evolution of these books has followed closely the development of the industry, and a comparison of the text-book of to-day for the would-be electrical engineer with that which served the same purpose thirty years ago is one of the most striking ways in which the development of electrical engineering can be realised. Yet the fundamental principles on which all electrical work depends are unaltered, the laws of magnetism have not changed; the difference between the books is in the point of view from which they are written. The older work was a text-book of applied physics; it described physical phenomena and apparatus on a small scale, while the later books deal with measurements and machinery on the engineering scale of practical work. Although Dr. Hay's book appeared over eight years ago the new edition has not altered so much as might have been expected, and there could be no better evidence that the author in the first instance had judged the needs of the modern student rightly, that he had justly held the balance between physics and engineering, and that he had produced a book which was of real value to the budding engineer. The present volume is not a mere encyclopædia of electrical apparatus, it is founded on the rock of sound physical principle, but it is a discriminating book, it deals with essential facts, and fundamental laws stated as lucidly as they have ever been stated in any similar text-book. In the opening chapter the definition of the electromagnetic unit of current serves as the starting-point, followed by some fundamental theorems relating to electromagnetic induction and the magnetic circuit. The way in which these general theorems are established is admirable in its simplicity, and absolutely rigid in its method. The average student should be able to follow the proofs quite easily; yet, if he has thoroughly mastered them, he will have gone a very long way in his education, for he will have laid a foundation on which the whole superstructure of his knowledge must be built. In this chapter we have, in ten pages, the groundwork of continuous current electrical engineering. In no other well-known text-book has so much been compressed into so small a space.

In the next chapter are laid down the laws of electromagnets, the definitions of the quantities that determine magnetic quality, and the methods of measuring it. In a footnote to the paragraph on the ageing of the magnets is given an approximate analysis of the best composition of magnet steel; in the next page a few data as to the most convenient size for a test ring of magnetic material, and this kind of information is given throughout the book. It is full of practical hints which will be of the utmost value to those engaged in experimental work. After a chapter on hysteresis

* *Continuous Current Engineering.* (Second Edition.) By A. Hay, D.Sc., M.I.E.E. London, 191 . Constable & Co., Ltd. 6s. 6d. net.

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and its effects follows one on measuring instruments, not encyclopædic, but containing carefully chosen examples of the best types. One may, perhaps, regret that so much space is occupied by a description of the multicellular voltmeter and the details of the Kelvin standard balances, as these instruments are now not very often found in testing laboratories; one may criticise also the figures given at the end of the chapters of the prices of the instruments of the different types. Everyone knows, nowadays, only too well, that prices are very variable quantities, which manufacturers, as a rule, are not averse from giving whenever they are asked for them. A useful chapter on the calibration of instruments follows, together with an account of some characteristic types of continuous current meters. Here, again, one may be inclined to criticise the amount of space given to a description of the Aron clock meter, which is not much used in this country, though the meter is one of the most interesting, from the scientific standpoint, that have ever been built. The chapter on the dynamo is extremely clear, and the illustrations showing the form of an element of lap or wave winding are such that they should enable the dullest student to comprehend the arrangement of these windings, a subject which is usually a thorny one for most beginners. This chapter is one of the most successful in the book. In Chapter VII. armature reaction and commutation are discussed at some length; the simple theory of commutation based on Arnold's classical work stated, and with the aid of a few simple diagrams it is shewn how sparkless operation may be attained. Not only is the theory given, but rules for the running of commutators, and some analyses of the difficulties that arise and how they may be overcome. In the next chapter the methods of exciting dynamos are discussed and characteristic curves of the chief types are shown; the corresponding curves for motors are given in consecutive paragraphs. In this way the essential similarity between the motor and the dynamo is clearly brought out; a section of this chapter deals with motor starters and another with methods of speed control. The chapter on the construction of dynamos which follows makes no attempt to deal with design, though a few designing rules are given; it is an account of the way in which the dynamo is built up. The figures, like the others in the text, are diagrammatic; there is no attempt to give working drawings and dimensioned sketches. In an elementary book this may be excused, but most engineers would have preferred to see something more like an engineering drawing than those that are actually to be found. In Chapter X. the design of a field magnet system is fully set out and the methods of calculating the field coils for a machine are given. Next is a study of the losses occurring in a dynamo and the testing of a dynamo or motor for efficiency by all the well-known methods; the determination of temperature rise and the other tests with which the electrical engineer must be familiar.

Chapter XII. contains descriptions of a strange collection of machines, the Rosenberg train lighting dynamo, a turbo-generator and a homopolar generator. It is a chapter which may well be omitted at a first reading; in fact, the book would not have suffered very much had it been left out altogether.

The remainder of the book deals with what one may call "auxiliaries," though very important auxiliaries, in electrical work. There is a chapter on secondary batteries, which includes an account of the Edison Cell, and a description, necessarily brief, of the chief types of automatic boosters for controlling their discharge. Then

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follows an account of the electric arc and the chief types of arc lamps, a subject of interest, nowadays, because of the use of arcs for searchlights, though it may, perhaps, still be several years before the flame arc is entirely superseded by the newer high efficiency incandescent lamps. There is a description also of the magnetite arc and of the mercury vapour lamp. In this section one feels inclined to criticise the small amount of space that is devoted to incandescent lamps and gas-filled lamps. It will not be many years before lamps of this type are used everywhere, and the six pages allotted to them are hardly adequate; one would have liked to see a description of the life curves of some of these lamps and an account of the way in which the candle power of the lamp changes with the working voltage. Next comes a chapter on photometry, which includes an account of the Ulbricht Globe photometer as well as Trotter's well-known illumination meter and the flicker photometer of Simmance and Abady. The concluding chapters deal with switches of all kinds and with what one may call the properties of "electrical materials." If one wished to find a good argument against the inclusion of prices in a book like this, one could not find a better one than in the statement of the price of copper. According to this book it varies from £40 a ton to as much as £110 a ton; it must have been beyond the most sanguine expectations of copper merchants, three years ago, that they would ever receive as much as £150 a ton for copper.

Although there are minor points that call for criticism in this book, the number of them is small and they do not detract to any serious extent from its general excellence. One of its merits as a text-book lies in the fact that the author is not content with stating laws and principles; wherever possible these are amplified by numerical examples, fully worked out. In addition, examples are given at the ends of the chapters which the student can work out for himself. Anyone engaged in teaching knows how essential both these things are if the young engineer is to be able to understand his subject thoroughly and make use of his knowledge. For a first year engineering student there is no better text-book to be found, and even for men in their second year of study there is much that will prove of value and interest.

Transmission of Time Signals by Naval Radio Stations

THE following appeared in the 1915 edition of the list of "Radio Stations of "the United States":

"The transmission of time signals to vessels at sea by means of radio-telegraphy "was first accomplished in the United States in 1905, and this service, enlarged "and extended, has continued to the present time. This service is of the greatest "value to mariners, as it furnishes a means by which the time, as given by the "transmitted signals, may be compared with a ship's chronometer and the error

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" of the chronometer found. Similar comparisons over a number of days enable " data to be obtained by which not only the error may be found, but also the " chronometer rate, that is the rate at which it is gaining or losing.

" The noontime signals on the Atlantic coast are sent out through the coast " radio stations by connection with Western Union Telegraph lines from the United " States Naval Observatory at Washington, D.C. By the operation of proper " relays in electrical circuits the beats of the second of a standard clock in the " observatory are sent out broadcast as a series of radio dots, commencing five " minutes before the time of the final signal. By omitting certain dots in a series, " the comparison between the dots and the beats of the chronometer seconds can " be checked until the instant of local noon (seventy-fifth meridian time) is " reached. This is marked by a longer dot, which gives the time of exact noon. " A comparison with the chronometer time at that instant gives its error referred " to seventy-fifth meridian time. Applying the difference in longitude, namely five " hours, between the seventy-fifth meridian and Greenwich, which is the standard " meridian (or 0° longitude), the error of the chronometer referred to Greenwich " time is determined.

" Time signals are now sent out on the Atlantic coast only through the radio " stations at Arlington, Key West, and New Orleans. Signals from Arlington and " Key West which reach a zone formerly served by other coast stations, are sent " out every day in the year, twice a day—viz., from 11.55 a.m. to noon and from " 9.55 to 10 p.m., seventy-fifth meridian time. Time signals from New Orleans " are sent out daily, including Sundays and holidays, commencing at 11.55 a.m., " seventy-fifth meridian time, and ending at noon.

" In case of failure of the Arlington high-power station the signals are sent " out by the small set in the same station, and the stations at Boston, New York, " Newport, Norfolk, and Charleston are notified, and they each send the signals " broadcast.

" On the Pacific coast the time signals are sent broadcast to sea through " the naval radio stations at Mare Island, Eureka, Point Arguello, and San Diego, " Cal., and at North Head, Wash. The controlling clock for each station is in the " naval observatory at the Mare Island Navy Yard. Signals from Mare Island " are sent out every day from 11.55 to noon and from 9.55 to 10 p.m., one hundred " and twentieth meridian standard time. Those from North Head, Eureka, Point " Arguello, and San Diego are sent out daily, excluding Sundays and holidays, from " 11.55 to noon, one hundred and twentieth meridian standard time.

" To get the maximum clearness of signals the receiving circuit should be " tuned to that of the sending station. Arlington and Mare Island send on a " 2,500-meter wave-length, North Head and San Diego on a 2,000-meter wave " length, Eureka on a 1,400-meter wave length, Key West and New Orleans on a " 1,000-meter wave length, and Point Arguello on a 750-meter wave-length. On " the completion of the new radio station at the training station, Great Lakes, " time signals will be transmitted from that station for the benefit of shipping on " the Great Lakes, as well as the weather reports for that region, now transmitted " by Arlington after the Atlantic coast weather bulletin, following the 10 p.m. time " signals."

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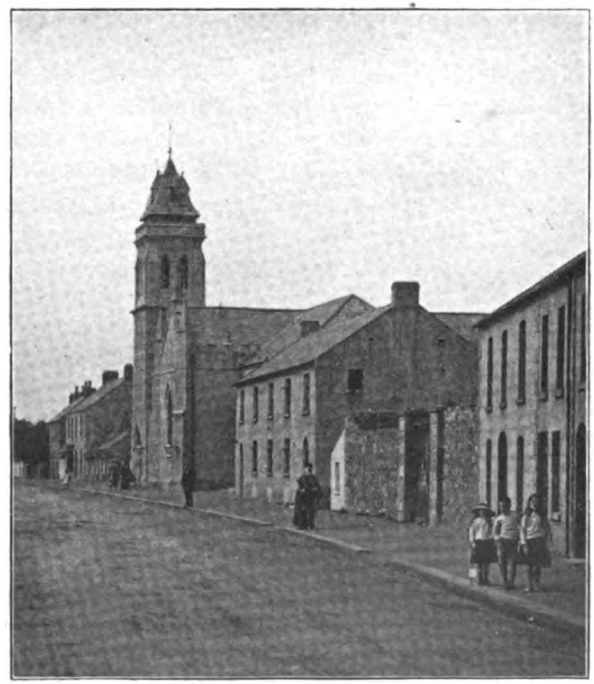
Sinn Fein Sedition

WIRELESS Telegraphy played an important *rôle* in the recent disturbances. The movements of the German vessel which landed the traitor Casement on the shores of Tralee must necessarily have been communicated through that medium.

A Dublin eye-witness of the dramatic events states that the insurgents succeeded at once in cutting the telegraph wires, with the consequence that there was no possibility of communicating with England except by means of Radio-Telegraphy. Then we have the story of the gunboat which played so important a part in preserving the Irish capital, and which was proceeding up the Liffey to refit when she received by wireless a message stating that serious trouble had broken out. The gunboat took action at once, and by its agency the quayside and Butt bridges were prevented from being overrun with the insurgents. Moreover, as soon as Connolly (who has since paid the penalty with his life) had gained possession of the wireless station at Stephen's Green, he used it for the purpose of sending out to the world the Procla-



CHURCH STREET, SKERRIES. THIS IS A TYPICAL IRISH THOROUGHFARE.

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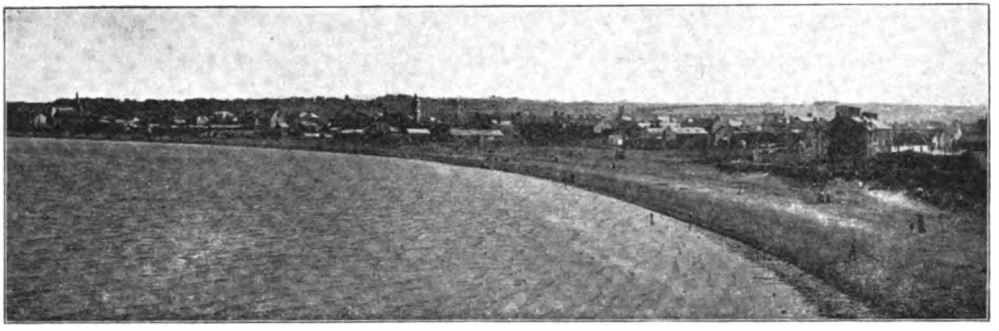

THE SOUTH STRAND, SKERRIES. THE FINE STRETCH OF SAND ADDS A PICTURESQUE TOUCH TO THE VIEW

mation of an Irish Republic. The insurgents also installed a wireless apparatus over the well-known establishment of Messrs. Reis, in Sackville Street, at the corner of Lower Abbey Street.

Perhaps the most dramatic incident, from a wireless point of view, consists of the way in which the Marconi Station at Skerries, Co. Dublin, was saved from rebel capture. The local police got word of the coming attack on Easter Tuesday. On Wednesday the rebels, after capturing the neighbouring villages of Swords and Donabate, marched on Skerries—the peaceful villagers gathering on a hill to watch the coming battle. In the nick of time a destroyer, undoubtedly summoned by the ether waves, came along at a great pace, and landed two hundred men of the South Staffordshire Regiment. These troops immediately entrenched the position, and saved the situation; for the rebels on learning of the destroyer's presence wheeled about and returned to Dublin. This latter incident forms the subject of the following poem, which is from the pen of an Irishman born close by the district which forms the scene of action :—

I see it now, as long ago,
The quaint old fishing town,
The cottages with whitewashed walls,
The thatched roofs worn and brown.

The fisher folk that come and go,
The trawlers in the bay,
And Wicklow's hills, that blue and dim
Stretch Southward far away.

Peaceful and still—yet whence those sounds
That from yon valley rise?
And whence that cloud of wrath that looms
Upon the Western skies?

It breaks with gleam of naked steel
Of bayonet and of sword,
While downward like an angry flood
Rush on the rebel horde.

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The trembling villagers descry
The terror drawing near ;
Whence shall they turn for succour now,
In this dread hour of fear ?

Send forth the voice that pierces far,
O'er circling sea and land ;
Tell of the perils gathering near,
The death on every hand.

Onwards the rebels press, they know
If once that voice be still ;
The town is theirs, and they are free
To work their wicked will.

Call yet again ! . . . at last, at last,
An answer faint, but clear.
From o'er the seas the succour calls,
" Stand steadfast, help is near."

Behold on yon horizon dim
That little cloud of smoke.
Hark ! hark ! the thunder's far away. . . .
It was the guns that spoke.

The good ship cleaves the mists, and now
She stands revealed in might ;
The rebel hordes in terror gaze,
Then break in headlong flight.

* * *

Thou'rt saved ! In peace thy dreams renew,
Old town beside the sea.
May memory of perils past
Make life more sweet to thee.

Saved !—and oh voice whose echoes reach
Through earth's most distant seas ;
Bring strength, bring courage unto men,
In perils such as these.

Answering the cry of terror sent,
Through nights of doubt and fear ;
Whispering, when death stands at the door,
" Be steadfast, help is near."

T. IDDON.

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Wireless Telegraphy In the War

"DER TAG."

OUR readers will have studied in our daily contemporaries many thrilling accounts of the great naval battle between the British and German Fleets on May 31st, and it would be undesirable for us to attempt any general description; but the part played by Wireless Telegraphy on both sides, all through the operations, was of the greatest importance, and it is impossible for us to omit all reference to the latest exploit of our glorious fleet. The first point to remember is that the encounter was not sought by the enemy. Vice-Admiral Sir David Beatty with his Battle Cruiser Squadron encountered the whole of the German High Seas Fleet in pursuit of an (unnamed) enterprise northward. Overhead the enemy Zeppelins, at an altitude probably of between 6,000 and 10,000 ft., were anxiously surveying the vast panorama spread beneath them, and maintaining constant wireless touch with the German Admiral. On the British side, as soon as Beatty realised that he could attack, he immediately sent a radio message to the High Admiral, and a narrative communicated to the Press by "one who was there" describes the arrival of that message in the following terms:

> "I shall never forget the thrill which passed through the ships of the "Grand Fleet when that inspiring message was received from the Battle Cruiser "Squadron many miles away: *I am engaged with heavy forces of the enemy.*"

We may be sure that, all through the battle, the wireless operators were kept hard at work receiving and transmitting, now announcing action on the part of themselves, or of the enemy; now issuing orders for concerted movements. It is plainly evident that the British Fleet was manœuvred with great coolness and tactical skill, which, however, did not interfere in any way with the dashing spirit of attack traditional in our naval service. Such manœuvring depends upon the accurate transference, by radio messages, of orders from ship to ship, and the naval operators concerned played their part as nobly as their comrades at the guns, or in the engine rooms. In this connection it is not without interest to observe that the German Emperor in his bombastic speech at Wilhelmshaven said in the course of his address to the sailors of his own battered Fleet: "Every one of you has done his duty. "At the gun, in the boiler room, and in the *wireless hut*, every one bent his mind to the

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"same end." In other words, he recognised the energies of the wireless men as ranking side by side in importance with those of the gunners and engineers. *Fas est et ab hoste doceri.*

The action was fought on the afternoon and night of Wednesday, May 31st, and the aftermath of the engagement could hardly have been over within the next twenty-four hours; in fact, it was not until the middle of Thursday, June 1st, that Sir John Jellicoe realised that there was nothing more to be done by the Fleet as a Fleet, and returned to his bases. This appears from the Admiralty report of Sunday, June 4th.

On the night of June 1st the German Admiralty made up a statement and issued it to the world, detailing their own losses and those of the British. How was that report made up? and what reliance could be placed upon its accuracy? Twenty-four hours later the British Admiralty in making up *their* first report were unable to speak with certainty regarding six of their own destroyers, and in their statement simply said, after mentioning the loss of five destroyers (which they named), "six others are not yet accounted for." Later information showed that, of those six, three returned safely to their base, whilst three were lost. It is evident then, that the British Admiralty had not received an inclusive report even of their own vessels, at a time when the German Admiralty professed to be able to speak with certainty not only about every important unit of their own fleet, but also about those of the enemy. Yet the British are at least as well served by wireless as the Germans, and the conclusion is irresistible that the German account was hurriedly and imperfectly made up in order to create the impression amongst their own people and neutral nations that the action had resulted in their favour. Germany's anxiety especially to impress America is evidenced by the fact that about mid-day on June 2nd they issued a bragging and inaccurate report by wireless *in English.* The net result is that the world at large received not only the first impression, but the first details and explanations from enemy sources. British correspondents at Petrograd telegraphing on Sunday, June 4th, state that the Russian morning papers contained "three columns of telegrams based on the announcement by the Admiralty at "Berlin, the speeches in the Reichstag, articles from the Chancellor's daily Press, "and *communiqués* issued by the Wolff Agency, but not one single supplementary "line from British official or semi-official sources. All that there has been from "our side so far has been less than half a column of Admiralty bulletins, which "appeared in last night's evening papers here." Such a result is not desirable; the Russian people do not understand the British spirit sufficiently well to realise the cautious sobriety which prevented their acclaiming their victorious defeat of the enemy's object, accompanied as we have subsequently learned, by the infliction of considerably heavier loss upon them than was sustained by ourselves. Such intelligence would surely have been of the greatest practical interest to the Russians, who had for some time past been living under a constant threat of a combined naval and military attack. These recent losses will undoubtedly seriously affect German naval operations in the Baltic.

Lord Beresford in the course of a recent interview expressed his regret that the terms employed in the first British Admiralty announcement should have been open to the sinister interpretation which was, in fact, put upon it in certain

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quarters, and suggested that it would have been well to publish to the world, at the earliest possible moment, the simple statement that the German Battle Fleet had been brought to action in the North Sea, and after a severe and prolonged engagement had been driven back to its ports. Such an announcement transmitted through the British Wireless Long-Distance Stations would have sent a thrill throughout the world and created an impression which the German misrepresentations would have been utterly unable to efface. As it was, Germany was allowed to create the first impression, and she seized the opportunity of heartening her dejected subjects at home, and filling the Press of neutral countries with boastful vapourings. Representations of a similar nature have poured in from newspaper correspondents in Japan, Switzerland, and Roumania.

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A TRAGEDY OF THE AIR.

NOVELISTS have many a time and oft treated their readers to pathetic death-bed scenes. Charles Dickens in particular carried this kind of dramatic writing to extremes. There is something very appealing to human sentiment in the last uttered words of our fellow-creatures just before their spirits leave this "Earthly "Tabernacle" to meet their God. It has constantly happened that friends and relatives at home have received a letter from someone abroad, written indeed in life, but only received after the writer has passed away. There is a peculiar pathos attached to such communications, but even such as these are lacking in the dramatic element which characterised some wireless messages recently received from Russian aeroplanists, making their final trial flight near Odessa. The operator at work on the field station, which was receiving messages transmitted by the aviators, learned through the æther waves that the plane, on which the unfortunate men were flying, was behaving in an eccentric and erratic manner. Within a few moments, a further message announced the snapping of a connecting stay. Closely following, the telegraphist below caught the words, "We have no power over our machine." Ere many more minutes had elapsed came the despairing cry, "We are falling to death," and—as the machine lurched earthward in headlong disaster—the æther waves transmitted the last uttered speech of the men in their death-throe, "We are perishing; good-bye!" The final words had scarcely been transcribed before the machine crashed to earth in utter ruin, and life had been mercifully reft from the shattered wrecks of humanity before their companions reached them.

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"HOW NOT TO SAY IT."

A PARAGRAPH recently appeared in the Press which runs as follows:—"I do "not wonder that Jellicoe refuses to use wireless." To quote the phrase of Mr. Punch, this is an incident of "How not to say it." The Grand Fleet's commander is one of the greatest users of wireless in the world! What the writer meant was that Jellicoe would not bother about radiating "half-baked" reports to his chiefs at Whitehall, a compliment to the Admiral's good sense—and wireless!

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War Notes

Closing scenes and problems of the Kut tragedy.

THE closing scenes in the tragedy at Kut have been largely revealed to the world by wireless telegraphy. General Townshend's final radio communication consisted of the pathetic message: "I must have some food here "and cannot hold on any more." Just before his surrender a pre-arranged signal indicated that the gallant general's last message had gone through. Members of Parliament have very justly displayed considerable and persistent curiosity as to the conduct of the whole affair. The replies given by the responsible members of the Government would appear to refute the idea that the brave defender was sent against his will and despite his protests. At the same time, what does appear to await satisfactory elucidation is the failure to relieve him during the months for which he was able to hold out. The fact of his having originally issued full rations plainly indicates that General Townshend had acted on the assumption that relief would be speedy. It is noteworthy that amongst the various supplies dropped from aeroplanes during the latter phase of the beleaguerment that we find included amongst the miscellaneous items "various spare parts of wireless apparatus." Such a fact points conclusively to the importance of radio-telegraphy under such circumstances; because we may be quite sure that nothing except the most vital necessaries were transmitted by this ultra modern method.

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LORD KITCHENER

Wireless Telegraphists of every rank and in every clime pay their tribute of sorrow at the loss of the great soldier recently reft from us at the very moment when the consummation of his life's labour had been attained. Pre-eminently a worker in the highest sense of the word, the message he has left for us all may be summed up in the pithy but pregnant phrase, "Carry on."

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Russian Wireless at Trebizond.

A terse but very welcome radio message was received on the occasion of the occupation of Trebizond by the Russian Forces. The troops of the Grand Duke Nicholas, after their stupendous and victory-crowned labours, were prepared to find their advance upon this Black Sea port strenuously resisted by the Turco-Germans. Preparations had been made for the Russian Fleet in these waters to support the troops in their attack when a wireless message arrived announcing that "Trebizond is "surrendering." The Muscovite warships, therefore, instead of co-operating with

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the land forces, proceeded at full steam to follow the Turks, and harass their retreat along the shore. This operation was carried out in a very masterly manner and troops were landed from the ships to play a decisive role in the Trebizond drama. The Russian seaplanes appear also to have given a good account of themselves, following closely the wireless instructions issued in accordance with the general plan of the Russian Commander, Admiral Eberhardt.

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Log of H.M.S. "Bristol."

We have many times referred to the value of the wireless warning advising the outbreak of war, which enabled the German ships in various parts of the world to escape the otherwise inevitable fate awaiting them from the British Navy. But it was not only the enemy who was able to utilise this medium for war-warning purposes. An interesting set of pen pictures under the title of the "Log Series" is being published by the Westminster Press, of 11, Henrietta Street, and one of their recent issues consists of the *Log of H.M.S. "Bristol,"* contributed by Mr. Wm. Buchan, leading signalman. He describes how the *Bristol* had been ordered to Mexico, and after spending some time there, was suddenly despatched to Jamaica. On Tuesday August 4th, at 9 p.m., it was announced on board "War on Germany was declared an hour ago"; two days later the *Suffolk* sent a wireless message to say she had the enemy in sight, and the *Bristol* cleared for action. The enemy cruiser turned out to be the *Karlsruhe*, and the two vessels were soon engaged in naval combat. The *Karlsruhe*, however, speedily "got her fill," and was enabled by her superior speed to steam out of danger.

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Enemy wireless in Central Asia.

Some extremely interesting facts came out in the course of an interview granted by Lord Hardinge, ex-Viceroy of India, on the occasion of an interview granted to the London correspondent of *The New York Times*. The subject dealt with was the resistance of India and Persia to Teutonic intrigues. After referring to the general loyalty which enabled England to denude her great Eastern Empire of British troops and almost strip these vast possessions of artillery, Lord Hardinge went on to make mention of enemy intrigues in Persia and Afghanistan. With their usual foresight, the Germans had prepared for action by installing wireless stations at Ispahan, formerly the capital of the Persian people, and still the religious centre. The German propaganda in Afghanistan was equally elaborately organised, and a systematic series of caravans were despatched hither by Prince Reuss from Teheran. Up to the present there are, however, no signs of any serious headway having been made by such propaganda, aided though it undoubtedly has been by the radio-telegraphic establishments in Persia. The German Emperor's persistent attempts to impress the Mohammedan nations with his benevolent patronage of Islam has "landed" him in many awkward dilemmas in various parts of the world. "Baksheesh" is the agency responsible for any little real progress he may have made; Orientals are "case-hardened" to flattery and "Bazaar Vapourings"—even by wireless.

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A Year in the Near East

Some Recollections of Wireless Service on the Egyptian State Yacht

By Percy W. Harris

With Illustrations by the Author.

WIRELESS operating as a profession will lead a man to many climes, and, although most of the work takes him on the high seas and busy transocean routes, occasionally there are positions to fill of more than ordinary interest, such as that I occupied for a period in the service of Abbas Hilmi, then Khedive of Egypt, now a declared enemy of the British, sheltering in Austria.

I often sit and turn over in my mind the experiences in that crowded year. They were many and varied, some in the winter gales of the Ægean Sea, others amid the mosques and gorgeous colourings of Constantinople; others, again, took place in the half-civilised regions of Asia Minor. As I have never yet written an account of them, and because they show that the life of a wireless operator is not all regular sailing across the Atlantic, I will endeavour to recall a few here, for the benefit of those who prefer to read of actual happenings rather than the adventures of fiction.

The Egyptian state yacht *Mahroussa*, which I joined at Alexandria in the spring of 1912, was an old vessel, dating from about 1870, when she left the yard of a Thames-side builder as a two-funnelled paddle steamer of some 4,500 tons. This was in the time of Abbas Hilmi's father, and upon the accession of the new Khedive, at an early age, he requested the Egyptian authorities to furnish him with a new and modern vessel to replace the *Mahroussa*, but for some reason best known to the Oriental mind his request was unfavourably received.

Now, although the Egyptian authorities would not provide a new vessel, they offered no objection to the proposal that the yacht should be sent to Europe for refitting, and accordingly she set sail for the Clyde, carrying with her the British commander, some four or five British engineers, and native officers and crew.

For nearly two years the *Mahroussa* lay in the Clyde, and before she returned to the sunny Mediterranean she had been completely transformed and now appeared

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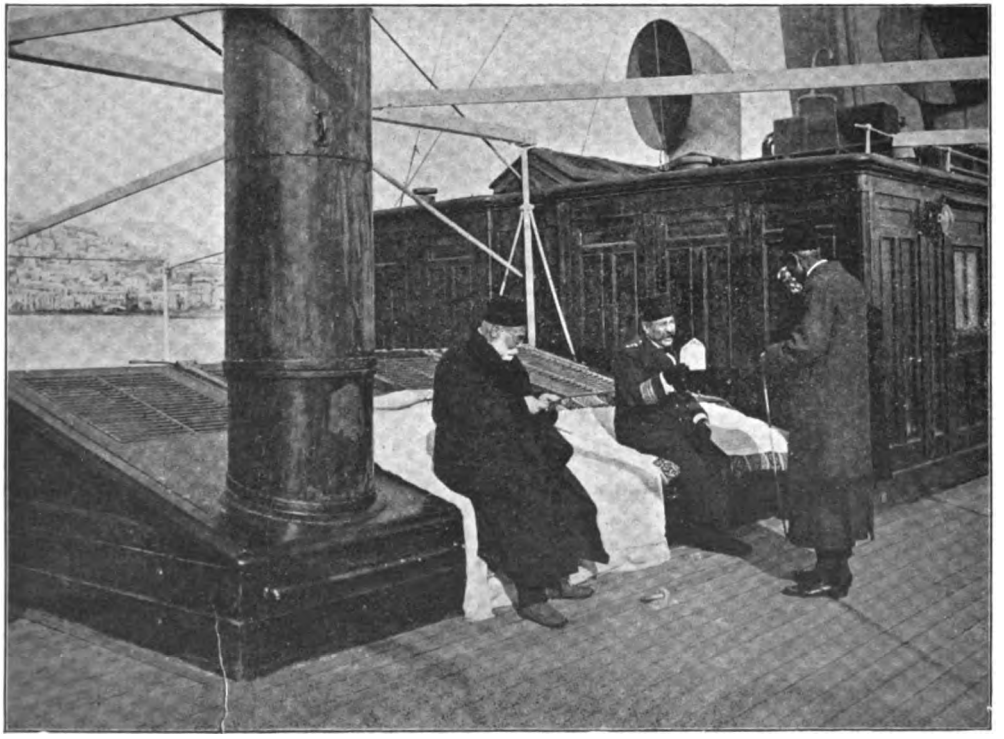
with a single funnel, modern boilers, triple screw turbines, and every modern device known to shipping. Like the Irishman's watch, little remained of the original, and, as I happen to know that the change cost £110,000, not much can be said on the score of economy.

The most amusing part of all relates to the officers and crew, who, considered as being on foreign service, were paid what amounted to double wages for the two years they remained idle in Scotland. The engineers, mostly Scotch, fully appreciated receiving such ample remuneration for staying at home in ease and idleness, whilst the native crew explored Glasgow from end to end, much to the amusement of the inhabitants.

In the spring or summer of 1911, some time after the *Mahroussa* had returned to her old home in Egypt, the Marconi Company received instructions to equip her with wireless apparatus, and accordingly a five kilowatt battleship installation was fitted. The apparatus has already been described in this magazine (Marconigraph, February, 1913), and it will suffice to mention here that the transmitter operated from a set of 42 large accumulators and had a disc discharger. The receiver was of the valve type; a magnetic detector and multiple tuner were also fitted.

I had scarcely unpacked my trunk and inspected the apparatus when orders came to sail for Dalamon, an estate belonging to the Khedive in Asia Minor and



AN EGYPTIAN PASHA AND THE YACHT'S DOCTOR SITTING BY THE WIRELESS CABIN OF THE "MAHROUSSA."

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THE COMMANDER OF THE "MAHROUSSA"

having for its port the land-locked bay shown in the heading to this article. We had on board a number of agricultural implements, and after these were landed we returned to Egypt to fetch the Khedive himself. I must confess the first sight of my princely master did not impress me greatly, for his appearance was that of a short, stout European with a double chin.

Upon our return to Dalamon my wireless duties consisted in transmitting and receiving a great volume of traffic with the station at Port Said, 350 miles distant to the south-east. The messages were usually from 30 to 300 words in length, many in secret cypher. Most of the work was done at night, and I can say without boasting that few men have worked as I did in those silent hours of darkness, with the telephones glued to my ears and a hand to the starter handle ready to give the monotonous "Rd" "K" as bell after bell sounded and echoed through the night air.

Of course, there were bad nights and good nights. The bad nights could be very bad, what with atmospherics wiping out almost everything and the jambing of the Italian battleships and cruisers in the Ægean (for Turkey and Italy were then at war).

It was not long before an interchange of courtesies in bad French with the operator of the Italian flagship at Rhodes made it fairly obvious that I was interfering somewhat, and after a while a polite telegram from the Admiral to the Commander of the *Mahroussa* requested a working arrangement. The Khedive grumbled, but after a little time it was settled, and a programme enabled us both to clear off our "stuff" without trouble.

When we left Dalamon the orders were to steam to the Dardanelles and thence to Constantinople, and the scenery as we wound in and out of the Ægean Islands was beautiful in the extreme.

We had scarcely left the shelter of Dalamon Bay and sighted the famous harbour of Rhodes when I came for the first time into contact with the realities of war. From out of a snug little hiding-place a sleek Italian destroyer with guns trained full on us came speeding across the water and signalled to our commander to stop. I may here mention that the Egyptian flag which we were, of course, flying was identical with that of Turkey, Italy's enemy, and an inspection, therefore, became necessary. After a few particulars had been given to the lieutenant on the bridge we were allowed to proceed

ONE OF THE TURKISH OFFICERS.

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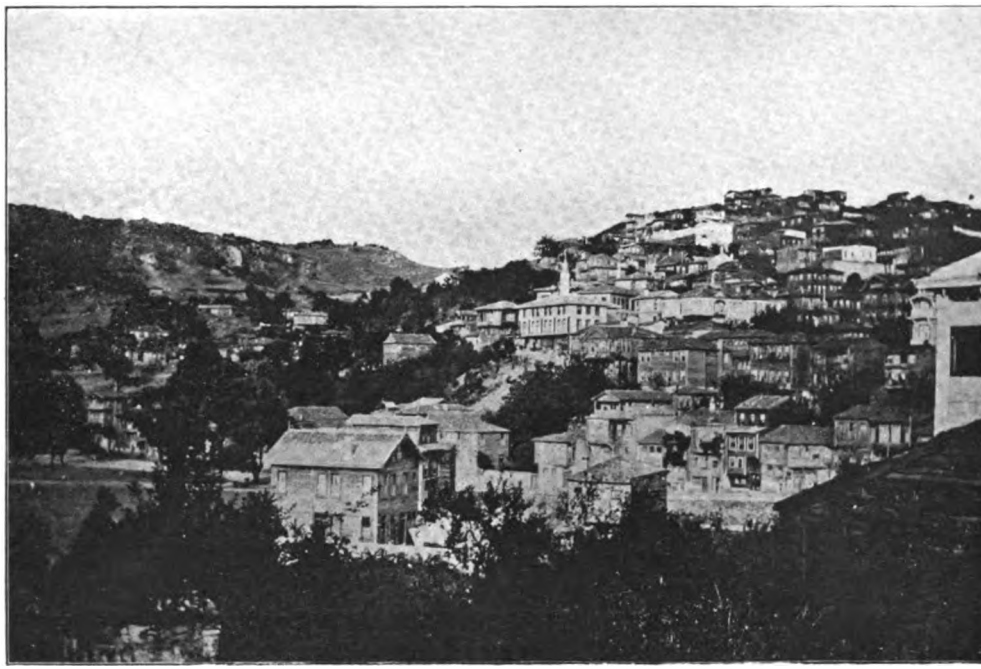

"OUR RESTING-PLACE AT BEICOS, A PRETTY VILLAGE SOME TEN MILES FROM CONSTANTINOPLE."

on our way, and in due course came to Tenedos and the entrance to the famous straits.

Instead of entering the Dardanelles, however, we continued up the Ægean to Dedeagatch, a port then Turkish but since acquired by Bulgaria. Here the Khedive went ashore for the purpose of finishing his journey by rail, as the Dardanelles were heavily mined and he did not relish exposing himself to the danger. As to the yacht's officers and crew, I suppose they did not matter; so the *Mahroussa* turned back, and in a few hours came again to the forts at the entrance of the famous waterway.

A day of steaming through the mined waters of the Straits and the Marmora (they were not very interesting then) brought us to Constantinople, and after a short pause off Seraglio Point we steamed up the Bosphorus to our resting-place at Beicos, a pretty village some ten miles from Constantinople itself and not far from the Black Sea. Here we anchored and lay in idleness from the end of May until the following October.

One of the first things I did as soon as we were settled was to see whether it was still possible to communicate with Port Said. On this point I had doubts, as a glance at the map showed that a distance of some 650 miles separated us, nearly a half of it being overland. Of course, in daytime such communication was quite out of the question, but at night in good conditions I found that we could get signals through quite well.

Of the happy days in Constantinople, the visit to Saint Sophia, the picnics with the British residents to the shores of the Black Sea and many other interesting

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events I must not speak here, for nothing less than a book would do them justice. Suffice it to say that when we heaved the anchor aboard and left again for Egypt I felt a strange wrench in parting from the loveliest district I have ever known.

We called at Dalamon on the way back. On this occasion there happened a dramatic little incident, humorous in some ways, but only saved by whim of fortune from ending in tragedy. Late one afternoon, following on a gorgeous day, I chanced to be leaning against the rail contemplating the distant scenery when a black object came in view rounding one of the islands at the mouth of the bay. Picking up my field glasses, I made out a boat, and as it drew nearer I perceived that the sole occupant was a Greek priest, patriarchal in appearance, with a flowing white beard and long black robes. Across the glassy water he rowed sturdily and rhythmically, and before long drew up alongside, an Egyptian marine running down the ladder to meet him.

From where I stood I could not hear what he said, but it was evident from the buzz of conversation which spread along the deck that something was wrong. The Khedive, who happened to be on board, was advised, and on enquiry I found that the priest, knowing the yacht to be at Dalamon, had rowed in, post haste, from a neighbouring district to tell us that the brigands had come down from the hills to raid his village. And then, as the novelist would say, all was bustle and excitement! Both steam launches were lowered and lifeboats filled with soldiers of the Khedive's Guard were hitched to them. A couple of native officers and an official or two climbed in, and off across the bay the expedition sped, leaving a trail of white foam.

We waited patiently for an hour or two, and then, after darkness had fallen and as the jackals were beginning to howl in the adjacent woods, two specks of light in the distance showed where the returning launches were rounding the islands. Everybody was on deck watching the lights as they grew brighter and nearer, and directly the returning force came within hailing distance many excited enquiries were shouted across the water. The expedition had proved a very tame affair, however, for on arrival at the village the cry of "brigands" turned out to be a false alarm. It is just as well it did, for I found just afterwards that not one of the soldiers had a single round of ammunition to put in his rifle, and there had been none on board for two years!

(*To be continued.*)

A VIEW OF DALAMON BAY FROM THE SHORE. THE "MAHROUSSA" IS ANCHORED ON THE RIGHT.

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To Our Readers

SENTENCES which meet the eye in the course of casual reading often institute a long and seemingly disconnected train of thought. A case in point occurred recently when our attention was arrested by a phrase in one of our contemporaries: "Wireless telegraphy possesses an unaccountable fascination for the youthful mind." The fascination is obvious, but its full realisation and significance are less apparent. In early days this applied science was largely indebted for its excitation of popular attention to the sense of mystery which surrounded it. Ordinary wired telegrams had become familiar; the fact that the visible connection of a tangible metal wire had to be established between two points before communications could pass, had done away with the original feeling of wonderment at what in the earlier part of the nineteenth century was looked upon as an electrical marvel.

Radiotelegraphy eliminated the wire and the visible connection, and fired the popular imagination by apparently casting messages away into space to snatch them back from infinity at the other end. This invisibility of connection is still accountable for a good deal of wonderment on the part of the large number of folk who are less familiar with the facts of the universe than most of us like to believe to be the case with ourselves.

A passenger goes on board one of our great ocean liners, and is perhaps fortunate enough to be allowed the privilege (very charily extended) of visiting the wireless room. Here sits a young man surrounded by various mysterious pieces of apparatus, ready to accept even in mid-ocean a message for transmission to the sender's house, perhaps thousands of miles away. The little cosmos on board is apparently isolated from the rest of the world by a vast expanse of air and water, and at first sight there seems something uncanny about the operation. The wireless room takes on the semblance of a wizard's cavern. The ocean traveller feels like an investigator of the occult who finds himself in a laboratory of some mediæval necromancer, who, surrounded by phials, retorts, cabalistic diagrams, and other paraphernalia, is bending over a glowing brazier in search of the "transmutation of metals" or distilling lustrous liquids in pursuit of the "elixir of life."

Such an allurement is, however, founded upon illusion, and the real fascination of wireless telegraphy lies in the fact that its actuality is even

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more imaginative and poetical than the mysticism of mediævalism. Men are to-day rapidly outgrowing the state of mind which can see no poetry or romance except in the trappings of bygone ages. Our modern artist finds it unnecessary to indue men and women with antique costumes in order to impart to them the feeling of romanticism demanded by a picture portraying sentiment. Long ago Wordsworth dared to speak in his description of a perfect woman of "the very pulse of the machine," whilst Kipling in one of his most delightful poems describes in throbbing verse the feelings of a Scotch marine engineer with regard to his engines.

To-day's knowledge affords more food for imagination and more delight for the poetic soul than all the phantasies of bygone ages. Take, for example, the cosmogony of Milton's "Paradise Lost," one of the grandest poems in the English language, and consider it side by side with the conception of the universe inculcated by modern science. Milton's "Ptolemaic System" figured the earth as the centre of a number of transparent spheres revolving one within the other "cycle in epicycle, orb in orb." This system of spheres hung "pendant at the gates of heaven," surrounded by an inchoate mass of mingled yet unmingled solids and liquids entitled chaos, whilst below stretched the gloomy abode of hell. Modern science pictures for us a series of universes kept together by no material bonds, but maintained in delicate equipoise by the action, reaction, and counteraction of diverse forces. These universes float in a limitless space filled with ether, which alone enables the waves of heat and light (and who knows what else ?) to pass from point to point. There seems little doubt as to the comparative poetic merit of the two conceptions. Perhaps the strongest and most abiding spell cast by radio-telegraphy over the human mind lies in the fact that the more its problems and effects are studied the more vivid becomes the realisation of this vast and all-pervading ether. Wireless telegraphic fascination may have started with distorted vision, but is becoming fixed and intensified by knowledge.

The Editor

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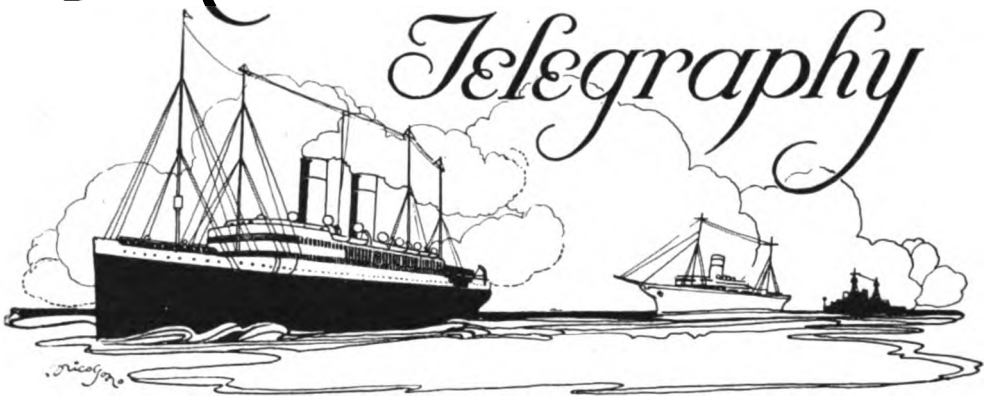
Maritime Wireless Telegraphy



Wireless Call for Aid.

When the steamship *Alamo*, which found herself in difficulties 130 miles off Cape Hatteras, sent out wireless appeals for help recently, the cutter *Onondaga* went to her assistance. It is gratifying to know that there are watchful ears ever ready to receive and act upon the calls of vessels in distress. The dangers of the seas are well known, but wireless telegraphy goes far to obviate the terrible catastrophes which have occurred from time to time.

* * * * * *

A Novel Marriage Proposal.

Our contemporary the *Wireless Age* prints the following paragraph, which we think may interest our readers:

A newspaper relates that a new feature of wireless telegraphy has recently had a demonstration in Connecticut. A young couple in the Nutmeg State had a misunderstanding. The young man started for the West Indies on a fruit steamer. Along came St. Valentine's Day, and the young woman changed her mind. Her sweetheart was well out to sea on his voyage. She bethought herself of the wireless, and sent through the air the statement: "I have changed my mind. This is leap year. Will you have me?" This brought a quick response: "A great valentine. Will return by next boat."

Wireless telegraphy has been useful in a great many ways, bearing messages of war, of peace, of business, of sorrow, of joy and love, and perhaps hatred, but this is said to be the first time on record that a proposal of marriage was ever made by Marconigram by a young woman, and acceptance returned by the same means.

* * * * * *

Medical Advice by Wireless.

"Master Frederick VIII.: Please have your Dr. state symptoms and treatment "for appendicitis immediately.

"Capt. Banvard."

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This was the message from the Standard Oil tanker *Brindilla*, which was delivered to the captain of the Scandinavian-American liner *Frederick VIII.* by his wireless operator one evening recently, while the vessels were at sea. The ship's surgeon immediately diagnosed the case and directed by wireless the treatment to be given the patient by the captain of the Standard Oil tanker. Under the doctor's instruction, Captain Banvard administered opium and applied ice bags, continuing his treatment until the ship reached port.

* * * * * *

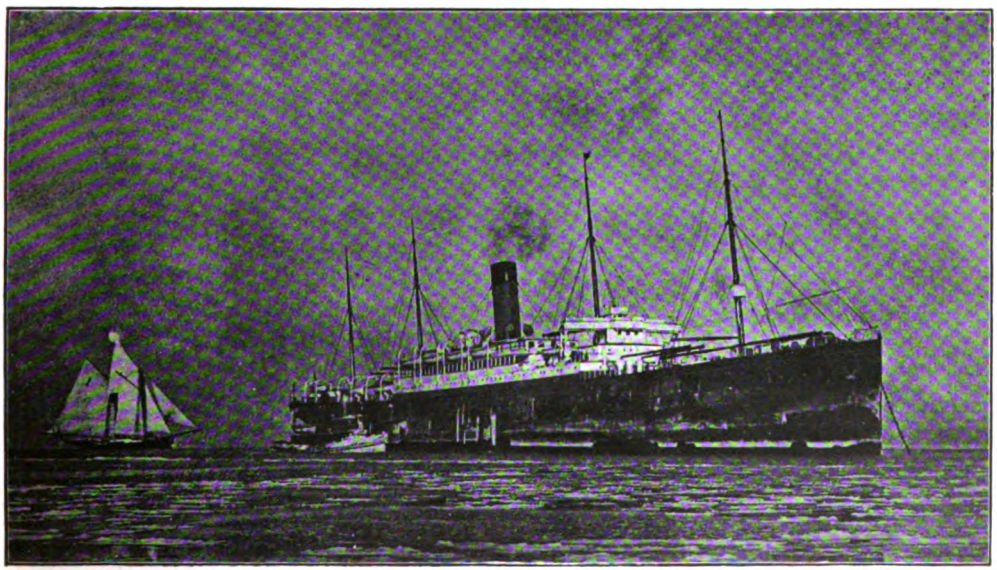
S.S. "CYMRIC" TORPEDOED WITHOUT WARNING.

According to messages from Queenstown, the White Star liner *Cymric* was torpedoed, and sank eleven hours after she was attacked. Five of the crew were killed, whilst the remainder were landed at Bantry.

The captain of the *Cymric* states that when eight days out from New York, and 138 miles from land, his ship was torpedoed without any warning. The track of the torpedo was seen by several, but the submarine itself was not seen. The torpedo struck the engine-room and went through, exploding on the far side. It blew all the skylights off and all lights out. Four men were killed by the explosion, and the chief steward was drowned while leaving the ship. The rest, numbering 105, were all saved.

All left the ship and took to the boats, but later returned and sent out a wireless call on the emergency gear. They received an answer to the effect that a rescue vessel would be sent without delay. A sloop subsequently arrived, took off everybody, and stood by till the vessel sank.

There were no passengers on board the *Cymric*, and the crew were all British,



[Photo: "Daily Mirror."

S.S. "CYMRIC," OF THE WHITE STAR LINE. SHE WAS TORPEDOED AND SUNK WITHOUT WARNING 138 MILES FROM THE NEAREST LAND.

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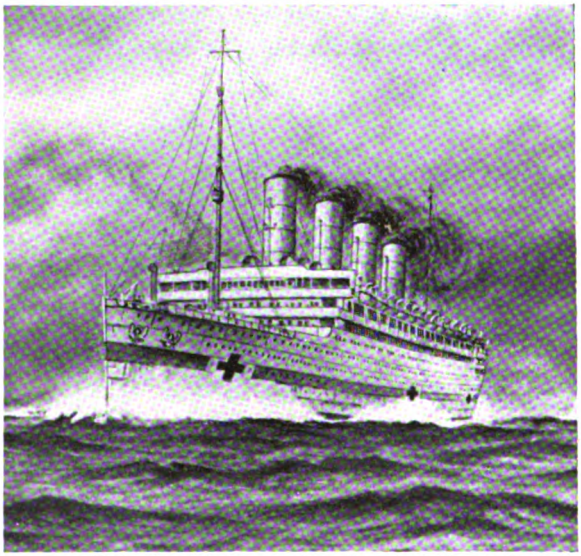
with the exception of one Russian and two Belgian subjects. The *Cymric* had no gun of any kind mounted.

The value placed on the *Cymric* for marine insurance was about £85,000.



Reproduced from a water-colour painting by P. Aris.

H.M.H.S. "AQUITANIA" OFF CAPE USHANT.

The *Cymric*, of which we reproduce a photograph, was a twin-screw vessel of 13,370 tons, built by Messrs. Harland and Wolff in 1898, and possessed a speed of fifteen knots.

* * * * *

THE HOSPITAL SHIP "AQUITANIA."

Since the advent of "two men" ships wireless operators have a little more leisure in which to indulge in recreation. We have pleasure in printing herewith a reproduction of a picture which Mr. P. Aris, a wireless telegraphist, painted whilst serving on board a merchantman some months ago. Mr. Aris is an artist, and when his ship passed H.M. Hospital Ship *Aquitania* one day, he thought it would form a good subject for a painting. This he executed in water colours, and our illustration is reproduced from it.

* * * * * *

AN ECHO OF S.S. "WAYFARER."

In the Admiralty Division of the High Court of Justice, before Mr. Justice Bargrave Deane, sitting with Trinity Masters, there has just come up for settlement a claim for salvage remuneration in respect of services rendered by the steamship *Framfield*. The help given was to the Liverpool steamship *Wayfarer* in the Atlantic Ocean. It will be recollected that while engaged on transport work and bound from Avonmouth to Malta under charter to the Admiralty, carrying troops and horses, the *Wayfarer*, a vessel of nearly 10,000 tons, was torpedoed or mined about 110 miles from Queenstown. The SOS signal was immediately sent out, as the vessel had a huge rent torn in her side. The *Framfield* happened to be in the vicinity and took the troops on board, eventually towing the transport, after a part of the crew had returned to her. His Lordship reserved judgment, remarking that it was a question whether the Admiralty's contract with the owners included salvage or not.

* * * * * *

AN EXCEPTIONAL DISTANCE.

While on a journey recently across the Pacific Ocean (from San Francisco to Sydney) the American steamer *Ventura* picked up wireless messages from the station at Tuckerton, New Jersey. She was 9,000 miles distant from that place. This forms in no wise a record in wireless reception, but at the same time it must be admitted that it is a very exceptional distance.

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A WIRELESS WORLD!

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The Special Problems of Aircraft Wireless—VII

By H. M. DOWSETT, M.I.E.E.

THE "BRUSH" OR "SILENT" DISCHARGE (*continued*).

From what has been said it is clear that the limit of safe working voltage on aircraft conductors situated in the neighbourhood of an explosive gas should be taken as that voltage at which the corona first shows itself, often called the "visual" voltage. The "visual" voltage is lowest for the sharp edges of a conducting surface and those parts of greatest curvature; for wires it decreases as the diameter gets smaller. Its value is proportional inversely to atmospheric temperature and directly to atmospheric pressure. At constant temperature and pressure the corona appears when the stress in the electric field at the surface of the wire reaches a certain definite value, called the critical stress.

For two parallel wires indefinitely far from earth:

$$R=\frac{V}{2r\ log_e\ s/r}\times\left(1+\frac{r}{s}\right)^2 \text{ very nearly,} \qquad (1).$$

where R = electric stress in kilovolts per cm.
V = voltage applied between the wires.
r = radius of wires in cms.
s = distance apart of wires in cms., centre to centre.

When the field is homogeneous, as between the centres of two parallel plates:—

$$R=V/s. \qquad (2)$$

This relation establishes the unit of electric stress, the "kilovolt-centimetre."

The great difference between the surface of a wire and the surface of a plate in determining the voltage which should be applied to obtain a given stress is illustrated by the following example.

Take the point marked on the curve Fig. 1 for wires of ·01″ diameter (·025 cms.), and suppose the wires are 20 cms. apart, then the volts (maximum) we should have to apply to obtain the stress given on the curve would be 16·8 kv. But if we were to use two flat parallel plates 20 cms. apart we should require 2380 kv., or 143 times as much to obtain the same stress. The curve Fig. 1 represents the mean of the results obtained by different experimenters* connecting the critical stress with the diameter of the wire. The critical stress increases as the diameter of the wire decreases.

The corona indicates loss of energy in the air in contact with the wire. This loss at the visual voltage is not very appreciable for wires of small section, but it

* Ryan, Watson, Whitehead, Peek, Petersen.

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suddenly increases as the voltage is raised (see Fig. 2),* the critical pressure being given by the approximate formula :—

$$E=\frac{17{\cdot}946\,b}{459+t}\times 350{,}000\ log_{10}\ (s/r)\times(r+{\cdot}07),\ \text{(Ryan.)} \qquad (3)$$

where E = critical pressure between conductors

t = atmospheric temperature °F.

b = barometric pressure in inches of mercury. .

An alternative formula often quoted is :—

$$e=308\ (1+0{\cdot}301/\sqrt{dn})\times r\ log_e\ s/r,\ \text{(Peek.)} \qquad (4)$$

where e = effective visual kilovolts to neutral.

d = density of the air $=\frac{3{\cdot}93\,b}{273+t}$

b = barometric height in cms.

t = temperature in °C.

n = number of cycles per second.

As an illustration take the case of the ·01″ diameter wire mentioned in connection with the Alexanderson test.† The critical voltage was given as 15,000 volts, which for argument we shall assume was obtained at normal temperature and pressure—60° F., 30″ of mercury. Suppose now instead of being placed 4 ft. apart the two wires were separated 10,000 ft., one being on an aircraft, the other on the earth. Then, other conditions remaining the same, the critical voltage would be increased to 25,500 volts. But other conditions will not have remained the same. At 10,000 ft. the temperature of the atmosphere—which falls at the rate of approximately 1° F. for every 300 ft. of ascent—and the barometric pressure—which falls at the rate of approximately 1″ for every 900 ft. of ascent—will also influence the critical voltage so that the value finally arrived at, instead of being 25,500 volts, would be 17,200 volts, or only 14·6 per cent. more than between wires a short distance apart and at ground level.

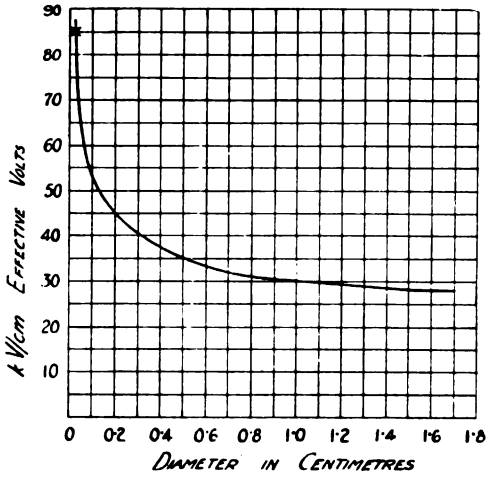

FIG. 1.

This is an extreme case, and is given to show that, provided the distance between the wires is a large multiple of their diameters, test values of visual and critical voltage obtained in the laboratory hold, when the conditions are apparently very different in mid-air.

In point of fact, it is not the height of the aircraft above earth which is of impor-

* Matthews and Wilkinson, "Extra-high-pressure Transmission Lines," *Journal Inst. Elec. Eng.*, No. 207, Vol. 46, p. 572.

† WIRELESS WORLD, June, 1916.

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tance as regards the corona, it is the minimum distance between the aircraft aerial and its balancing capacity, or between any part of its high-frequency circuits and neighbouring metal work—dimensions which are practically constant at whatever elevation the aircraft may be; also it is not the potential difference between two such conductors, but the potential difference between each individual conductor and the surrounding space and the intensity of the electric field on their respective surfaces which is essential to know, as owing to differences in shape and size the stresses involved tending to breakdown may be very different.

Take as an example an aircraft aerial and its balancing capacity, which together form a circuit somewhat similar to that shown in Fig. 3, where C is an oscillating coil having at one end a pointed rod and at the other end a plate, together forming a primitive air condenser. The intensity of the electric field will be greater at the point of the rod than on the surface of the plate; the dielectric current will therefore be greater, and the fall of potential in the air near the point corresponding to this current must also be greater than near the plate. As a result, if the voltage is gradually increased, a brush discharge will be visible from the point long before any discharge shows on the plate.

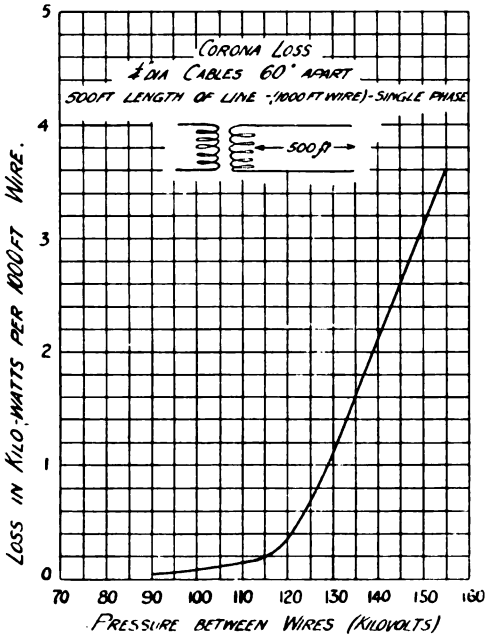

FIG. 2.

(See footnote * on page 297).

The reasons why the Zeppelin metal frame enclosing the gas bags can be safely used as a wireless balancing capacity when transmitting are mainly—

1. The very small electric stress which a given charge will produce on the frame compared with the stress the same charge will produce on the aerial hanging free in space.

2. The very high voltage which would be necessary in consequence to cause the stress to increase sufficient to cause a brush discharge on a cylinder the size of a Zeppelin.

For it has been shown * that a Zeppelin shell 525 feet in length, 50 feet in diameter in free space has 3·6 times the capacity of a No. 7/18 wire of the same length; then, if the wire is to produce the same total electric flux for unit rise of potential, it will have to be approximately 3·6 times as long as the Zeppelin. Now the intensity of this flux or the electric stress will be proportional inversely to the product "length by diameter" of each conductor, and if the Zeppelin has an intensity of 1 the wire will have an intensity of 1,158.

This huge ratio assumes the Zeppelin frame to be of sheet metal. Suppose,

* WIRELESS WORLD, Feb., 1916, p. 712.

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however, the metal in the frame only amounts to 10 per cent. of the superficial area, which is a reasonable figure, then the relative intensities on wire and balancing capacity will be 115·8 : 1. But, as shown in Fig. 1, the critical stress of a comparatively flat surface like the Zeppelin frame is only ·72 that of 7/18 wire, which in its turn is only ·45 that of a wire ·01 inch diameter.

Then, if we take the visual volts for the ·01 inch wire as a basis, it can be shown that the visual volts (maximum) above neutral for the 7/18 wire will be 54 kilovolts, and for the Zeppelin 8,950 *kilovolts*. Obviously, the largest power ever likely to be used on a Zeppelin would lead to no danger of fire from the tendency to brush of the metal frame used as a balancing capacity—a P.D. of 54 kilovolts, for instance, from both aerial and balancing capacity to neutral, at 500 cycles, the capacity being taken as 2,620 cms. would represent 29 kw.—*provided all the joints in the structure were in good electrical contact.* If they are not in good electrical contact, although the structure may be incapable as a whole of brushing in free space, minute sparks may take place from the badly connected members to the frame, and also the stress may be sufficient to maintain an arc between the parts when once it has been started by intermittent contact. These contingencies necessarily place a limit on the power which can safely be employed.

The Brush Discharge Due to Induction.

Danger on a Zeppelin, however, is more likely to result from the brushing on isolated wires not connected to the metal skeleton and on which, therefore, a comparatively high electric stress develops as the result of a small charge. Such insulated conductors in the neighbourhood of H.F. circuits, whether these circuits are of the closed or open type, are subject to a capacity induction which under favourable conditions may result in a serious brush discharge. It is not necessary that the conductors should be in electrical resonance with the exciting circuits, although resonance will intensify such effects, neither is it necessary that the conductors should be very near each other.

Dieckmann,* in discussing this question in relation to aircraft, mentions having observed brushing more than 50 metres away from the inducing circuit—presumably on aircraft, using normal aircraft power, although this is not definitely stated—and the distance could only be obtained on a wood-framed airship of the Schütte-Lanz type.

Thus the exciting circuit could be in the fore gondola and the brushing conductor in the rear gondola well out of sight of the operator. If steps are taken to stop all inductive brushing a serious source of danger would be removed.

Burning Due to the Brush Discharge.

An effect of brushing which often takes time to show itself, but which may none the less lead to fatal results if allowed to develop, is that of the burning of fabrics and materials which happen to be in its path. Exhaustive tests carried out in Germany in 1909–10 using a metal-framed balloon filled with coal gas showed that small sparks on or between parts of the frame whether due to induction or not, if of short period or low frequency, did not result in burning, but if they were maintained

* *Leitfaden der drahtlosen Telegraphie für die Luftfahrt*, 1913, p. 178.

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an appreciable time the balloon envelope resting on the frame commenced to burn. The gas emerged through the holes so formed, and while the burning edges slowly enlarged the gas continued to burn quietly without explosion. The ignition of gas in the close neighbourhood of ballonets made of unvarnished and rubberless cotton fabrics inflated at high pressure such as are used in Zeppelins was, however, difficult. The gas could only be set on fire by sparks of long duration.

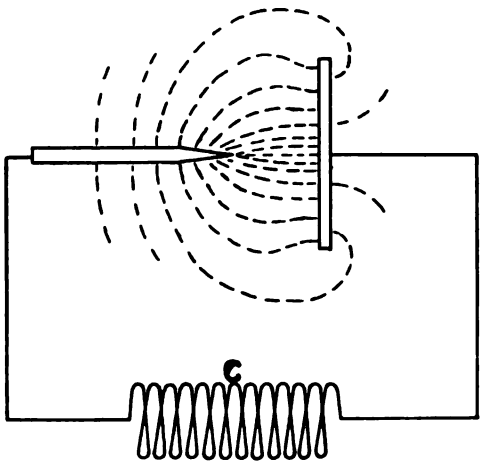

FIG. 3.

Insulating materials in the field of a brush discharge often intensify it, and they may burn or fracture as a result. Instances are given in E. F. W. Alexanderson's paper already referred to,* in which he described the difficulties which had to be overcome in the construction of an *H.T.*, *H.F.*, transformer, occasioned by the heating of the fibre spools on which his coils were wound, and the excessive losses in the varnished cambric insulation between the layers of the winding. Asbestos insulation also heated excessively. When carrying out some tests on the corona losses from thin wires, the cotton strings used to support the wires caught fire, and a porcelain insulator suspended from a cotton string which was then tried lowered the visual voltage on the end of the wire attached to it, and finally, due to the heat, broke into small pieces. This leads on to the important question of the use of insulators on aircraft.

(*To be continued.*)

"Morse Made Easy"

A NEW "WIRELESS PRESS" PUBLICATION.

Wireless students, boy scouts, Army signallers, members of volunteer training corps, and all who are endeavouring to master the mysteries of "dot and dash" will welcome the new Morse card just published by the Wireless Press, Ltd., at threepence. The system, which has been invented by Mr. A. P. Rye, enables the whole code to be memorised in a remarkably short time, and certainly far more rapidly than has ever been possible before. The system, which is simplicity itself, requires the student to learn one word for each letter, the word being selected for the long and short sounds contained in it. Thus the letter "c" (dash dot dash dot) is learnt in connection with "counterminer," the sound of which suggests the Morse construction. The word "aside" fixes the formation of the letter "a" (dot dash), and so on throughout the alphabet. Copies of the card, for which a great demand is anticipated, can be obtained from the publishers for 3½d., post free.

* "Dielectric Hysteresis at Radio Frequencies," Institute of Radio Engineers, Nov., 1913.

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Correspondence

To the Editor of THE WIRELESS WORLD.

DEAR SIR,—With reference to your article in the March 1916 number of THE WIRELESS WORLD, on page 800, entitled 'Wireless to the Rescue," it may perhaps interest you to learn that I had sent to the local Press on the 31st ultimo the enclosed letter *re* Wireless on Chinese Lighthouses, and I shall be glad to see it mentioned in your valued Magazine *for the sake of the many British Lighthouse-keepers.*

I am sending a circular to all the Lighthouse-keepers on the China Coast asking them to sign a petition to back up my suggestion on their behalf.

Yours faithfully,

Shanghai, April 27th, 1916. (*Signed*) F. X. SEQUEIRA.

Copy of letter above referred to :—

To the Editor of the "North China Daily News."

SIR,—Some few weeks ago you reproduced an article from a home newspaper relating to a case of hardship and privation endured by a certain lighthouse-keeper and his family. This reminds me that in July 1913, on a voyage from Tientsin to Shanghai, the Indo-China steamer *Lienshing* saw signals of distress from one of the lighthouses. The Captain stopped the boat and offered assistance. The lighthouse-keeper, while refusing assistance from the *Lienshing*, asked to be reported to the harbour authorities immediately the steamer should reach Woosung.

Supposing that the case of the lighthouse just mentioned should be a life and death one, and the lighthouse enveloped in a thick fog for a few days, would not that poor victim who perhaps needed a medical man to save his life succumb to his illness?

May I, therefore, most respectfully suggest to the powers that be to instal wireless telegraph instruments on all the lighthouses along the China coast? Now that wireless telegraphy is made so easy and cheap, there is absolutely no reason why the lighthouse-keepers should not be provided with this all-important life-saving invention.

It may not be generally known that for a comparatively small sum of money a complete installation having a radius of several hundred miles can be erected, while as for learning to operate, it is a simple matter of a few weeks' learning—a very trivial affair when the importance of the work is taken into consideration.

The lighthouse-keepers themselves, I am confident, would be the first to appreciate the advantage of a wireless installation. These poor men generally earn a mere pittance, suffer great privations and hardships, and run immense risks of losing their lives. Surely they ought not to be called upon to run unnecessary risks when a small sum of money would place them within calling distance of help and assistance by day and by night.

The upkeep of a wireless station is small, and I earnestly appeal to the British men in charge of the Chinese lighthouses to do something in this direction for their compatriots, who have chosen the arduous and risky life of a lighthouse-keeper under circumstances over which perhaps they had absolutely no control.

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In pre-wireless days the linking up of lighthouses with civilisation, telegraphically, was a very difficult affair, the submarine cables costing over £1,000 per mile, but with the advent of wireless all such difficulties are removed.

I have not dwelt on the many other obvious advantages to be derived by installing wireless on lighthouses, and I am confident that if so far nothing has been done in this direction it is more a matter of accident than negligence.

Thanking you in advance for publishing this letter.

(*Signed*) F. X. SEQUEIRA.

Administrative Notes

ARGENTINA.

ON January 14th, 1916, the authorities decreed that such radio-telegraph stations as are at work in places where there is no telegraph office will be considered as stations belonging to the nation, and the messages handled by them will be subject to the radio-telegraph charges which said stations exchange with ship's stations.

* * * * * *

JAMAICA.

The Direct West India Cable Company, Limited, which operates the wireless station at Jamaica, call letters VPH, advises that since April 1st last the Jamaica Post Office Telegraphs tax all inland messages six cents extra. The minimum charge therefore for the inland rate on messages "*via* Bowden" will be sixteen cents instead of ten cents on radio messages of ten words or less and one cent for each additional word.

* * * * * *

PACIFIC ISLANDS.

At a recent meeting of the Rarotonga Island Council, which was held early in the year, it was suggested that wireless communication should be provided between Cook Island and New Zealand, a site being already provided at Black Rock for the purpose.

* * * * * *

PORTUGAL.

All vessels wishing to enter the Tagus must approach the citadel at Cascaes in order to embark a pilot, and communicate by signals or wireless telegraphy their name and port of departure; they must comply promptly with all orders received, and hoist such signals and distinctive marks as the pilot may prescribe. No vessel may proceed into any of the entrance channels without authorisation from the semaphore station, which will be given by means of a signal known only to the pilot.

* * * * * *

UNITED STATES.

We are informed that the apparatus has been removed from the following wireless land stations in Alaska:—Koggiung, Clarks Point, Nushagak, Naknek, Karluk, Chinik.

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Among the Operators

THE LATE OPERATOR WOOLLEY.

It is with deep regret we have to announce the death of Operator Leonard Woolley, who passed away on May 12th, after an illness extending over two months. Mr. Woolley, who would have attained his majority this month, was a native of Leyton, and joined the Marconi Company's evening classes in September, 1913. After completing his training he was appointed to the s.s. *Kinfauns Castle*, on which ship he made several voyages. He then transferred to the *Cestrian*, and later served on board the s.s. *Turcoman*, *Coronado*, and *Camito*. Our sincere sympathy is extended to the late gentleman's parents.

* * * * * *

S.S. "CYMRIC."

Two operators were carried on board the s.s. *Cymric*, the White Star liner torpedoed by a German submarine. The two gentlemen in question were Messrs. W. Nicholas and P. C. Fisher, both of whom were returning to England after service abroad. Mr. Nicholas, the senior operator, has already figured in THE WIRELESS WORLD for April, when we told of the narrow escape he had in the fire on the s.s. *Bolton Castle*. Mr. Fisher, whose home is at Llanwit Major, is 21 years of age, and joined the Marconi Company's school in December, 1914, after a period of training at the South Wales Wireless College, Cardiff. Before being appointed to the *Cymric* he served on the s.s. *Moorish Prince*. Although both men were fortunately saved they had exciting experiences before reaching the shore. After the torpedo had exploded the stern commenced to settle down, and all believed the ship would founder. After a period, however, it was seen that the ship remained afloat, and the captain and Mr. Nicholas very bravely returned, repaired the apparatus, which had been damaged by the explosion, and eventually succeeded in sending out a call which brought speedy assistance. Great credit is due to Mr. Nicholas for this work, and we congratulate both men upon their fortunate escape.

OPERATOR P. C. FISHER.

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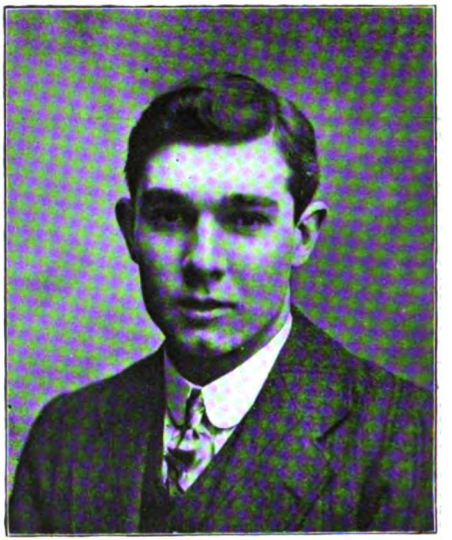
WRECK OF THE "RANGATIRA."

The s.s. *Rangatira*, which was recently wrecked and abandoned off the coast of the Cape, carried one operator, Mr. Alfred Griffith Hill, of Ulverston. Mr. Hill is 24 years old, and is an ex-Post Office man. His service with the Marconi Company dates from January, 1912. In February of that year he made his first voyage to sea as assistant operator on board the ill-fated *Oceanic*, and since has served on a number of vessels. At the time of the wreck Mr. Hill was upon his first voyage on the s.s. *Rangatira*, and fortunately escaped uninjured. He, too, is to be congratulated upon his escape.

* * * * * *



OPERATOR A. G. HILL.

OPERATOR W. MILLER.

THE LOSS OF THE S.S. "GOLCONDA."

Mr. William Miller was the operator on the s.s. *Golconda* recently torpedoed by the enemy. Born in Croydon twenty-four years ago he was educated in Newcastle-on-Tyne, where he later entered the services of the *Newcastle Chronicle*. Wireless telegraphy soon appealed to Mr. Miller, and in October, 1913, he entered the Marconi Company's school, subsequently being appointed to the s.s. *Scotian*. From this ship he transferred to the s.s. *Start Point*, and afterwards sailed on the *Golconda*. His next voyage was made on the *Ellora*, and on the completion of this he returned to the *Golconda*, upon which ship he remained until the disaster. We are happy to report that Mr. Miller is safe and uninjured.

The Jutland Naval Battle

In the next issue of THE WIRELESS WORLD we propose publishing a list of radiotelegraphists who lost their lives in the Jutland Naval Victory, and shall be glad to receive photographs of these gallant wireless men for inclusion in our roll.

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The Methods Employed for the Wireless Communication of Speech (iv)

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institution of Electrical Engineers, on February 2nd, 1916.)

Alternators and Frequency Raising Apparatus.

Owing to the extreme difficulty, which amounts almost to an impossibility, of designing and constructing an alternator of any of the usual types which shall be capable of generating an alternating current of the frequencies required in wireless work, attempts have been made from time to time to construct " frequency raisers " which shall be capable of raising the frequency of an alternator or other source, so as to bring it within the wireless range. This branch of the subject has recently been treated very fully by A. N. Goldsmith, so that only a brief abstract of the most important features will be given here.*

Frequency raiders as a whole may be broadly classified into two main divisions:—

(1) Frequency adders,

(2) Frequency multipliers.

To the first class belong most of the machine or alternator type of frequency raisers, while under the second are included the " static " frequency raisers, etc.

The distinctions between the two classes will be more apparent after a further consideration of the different methods by which the frequency of a current can be raised.

In the case of an ordinary (single-phase) alternator, the most usual construction is to have the fixed " armature " windings on the stator and the magnet windings on the revolving rotor. The frequency of the currents generated by such a machine depends then merely on the speed of rotation of the magnet system on the rotor and on the number of poles on it. A simple consideration then shows the practical impossibility of constructing a machine of this type to generate currents of wireless frequency with any available power (see Appendix I.).

Suppose, however, that instead of supplying the rotating field winding of our alternator with direct current, as is usual, we produce a rotating field by means of alternating currents—just as in the stator of an induction motor—and arrange the direction of rotation so that it is in the same direction as the direction of mechanical rotation of the rotor (and field windings). The magnetic field will then have a speed of rotation in space equal to the sum of the speeds of rotation of the field and windings separately.

The frequency of the currents that will be generated in the stator conductors will, therefore, depend on this speed, instead of merely on the speed of mechanical rotation, assuming the same number of poles on the fields in each case. In other

* See *Proc. Inst. Radio Engineers*, June, 1915; also *Electrician*, 75, p. 461, and p. 508, 1915.

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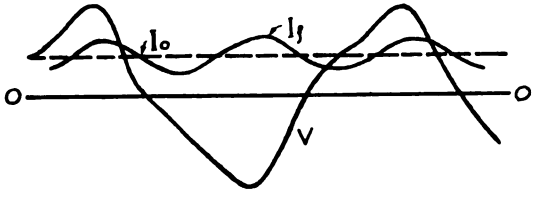
words, we have here the essentials of a machine for raising the frequency of a given supply current.

It is evident that a number of such machines could be connected in series, and the fields of one supplied from the generated currents of the previous one, and thus the frequency can be gradually raised from low values to high ones.

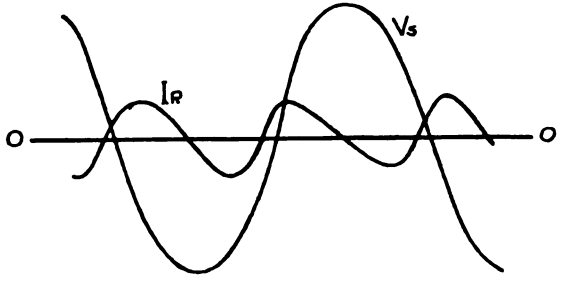
One of the best known frequency raisers which is of the alternator type is known as the *Goldschmidt Alternator* and consists essentially of an induction motor or alternator which performs the functions of raising the frequency by the method outlined above, but with the distinction that all the successive increments of frequency are arranged to take place in the one machine instead of in a number of such machines connected in series. It is well known that a single-phase alternating current can be resolved into two equal and oppositely rotating periodic quantities.

This explains the occurrence of the double frequency current observed in the rotor of a single-phase induction motor when it is driven at synchronous speed (slide, oscillogram), and also the double frequency ripple that is often observed on the field current of alternators.

In the Goldschmidt machine this double frequency ($=2n$) current is allowed to flow in a tuned circuit, and so attains considerable magnitude. By the same reasoning the field, due to this current, may be resolved into two oppositely rotating magnetic fields; as, however, the complete rotor is revolving with a speed corresponding to the frequency $=n$, one of these components has a speed relative to the stator of $2n-n=n$; and the other of $2n+n=3n$. This latter, therefore, gives rise to currents of three times the fundamental frequency in the stator windings, which can be isolated by means of a tuned circuit. The other component of frequency, n, merely augments the original currents of the fundamental frequency in the stator windings. This action can be repeated a number of times, each one giving an addition to the frequency, and being confined to its own tuned circuit, while the last is connected directly to the aerial and earth through the appropriate tuning inductances.



OSCILLOGRAM SHOWING DOUBLE FREQUENCY RIPPLE ON FIELD CURRENT



DOUBLE FREQUENCY CURRENT IN ROTOR OF INDUCTION MOTOR AT SYNCHRONOUS SPEED.

FIG. 13.

Machines have been

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constructed on these lines up to outputs of about 250 kw., and have been successfully employed for Transatlantic communications over distances of about 3,000 miles, but only as yet for telegraphic purposes, on account of the great difficulty of constructing a microphone to deal with the heavy antenna currents. (See section on Microphones.) An additional feature of these machines is the possibility of modulating their output by control of the field current, which, of course, only amounts to a small fraction (=from 5 to 10 per cent.) of the output of the machine. This leads to considerable simplification of the control apparatus, but it is not as yet proved whether this method is available for the higher powers of the larger machines.

It should be remembered, however, that all machines of this type suffer from the great disadvantage that they are frequency adders, and not frequency multipliers; and hence, if the initial frequency is not fairly high compared with the final one, such a great number of stages would be required that the arrangement would hardly be of much practical value from the economic standpoint. With frequency multipliers, however, the case is very different, and a rapid increase of frequency can be much more readily obtained.

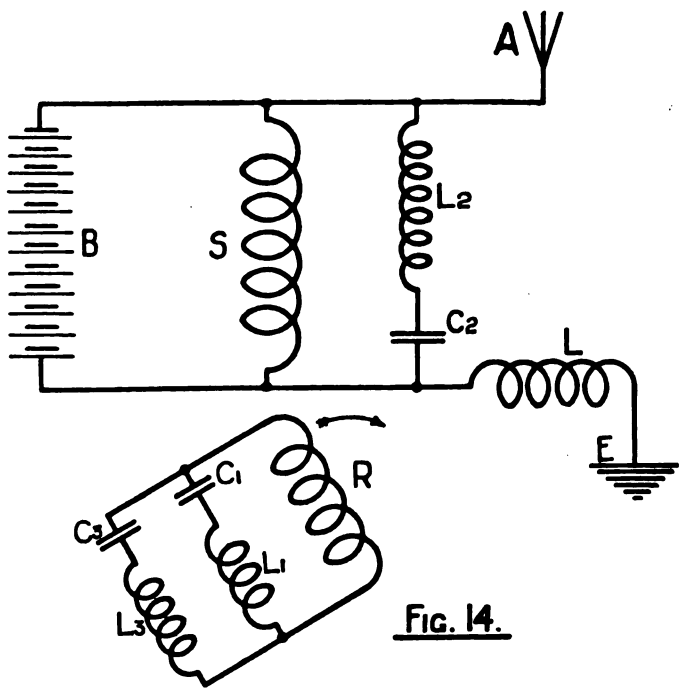

FIG. 14.

We now turn to the second class of frequency raisers—that is, frequency multipliers. The most important representatives of this class are the transformer frequency raisers, in which use is made of the fact that the magnetising current of a transformer working on a sine wave E.M.F. is generally very far from a sine curve.

The exact shape of this current curve depends on the state of magnetic saturation of the magnet core, and may be varied, within limits, to suit the requirements. The Fourier analysis of the above current curve shows that there is a prominent third harmonic present in the current wave. This will generally be found to be the case.

It is possible by suitably designed tuned oscillation circuits to strengthen this third harmonic by resonance, and therefore to obtain from a given A.C. E.M.F.

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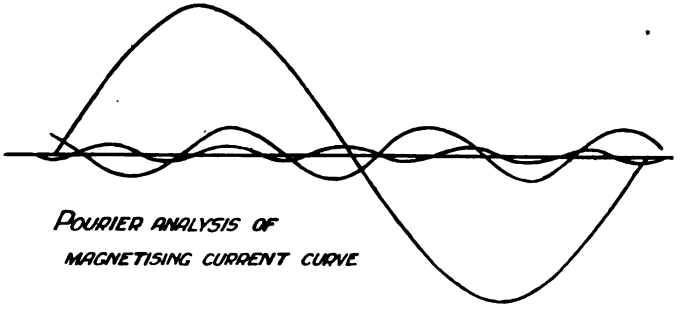
of approximately sinoidal wave form a current of three times the frequency of the original supply. This current may be utilised in a similar manner to produce another of three times its own frequency—*i.e.*, nine times the initial frequency, and so on.

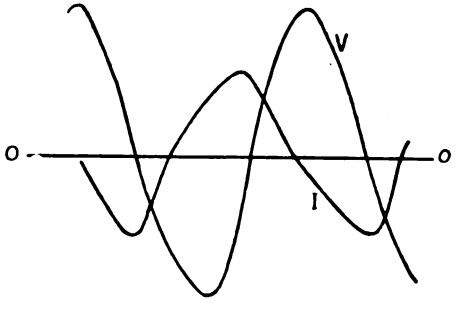
Comparing this method with the frequency adders, previously described, it is seen at once that a very much more rapid multiplication of the frequency is obtained, thus three stages would raise the frequency twenty-seven times. The great limitation to this method is that it is not very easily adaptable to handling large powers, since the magnetising current of a transformer is quite small ; while if much load is put on, the current becomes more sinoidal in shape, so that the triple frequency output is diminished.

If we superimpose both an alterating magnetisation and a steady magnetisation on to a transformer core it will be found possible to so arrange matters that the flux wave becomes unsymmetrical.

This indicates the presence of prominent harmonics which may be tuned out by appropriate circuits ; or, better, two such transformers may be connected up in opposition in such a manner that the fundamental or supply frequency cancels out in the secondary windings, leaving only a double or triple frequency harmonic which may be strengthened by resonance.

Mr. A. M. Taylor* has shown that it is possible to obtain a frequency increase as much as 27 : 1 by employing special arrangements with multiphase A.C. supply.





OSCILLOGRAM OF MAGNETISING CURRENT.

FIG. 15.

The greatest utility for these "static" frequency raisers, as they are often called, is obtained when they are used in combination with moderately high frequency alternators—*i.e.*, alternators designed for frequencies of, say, from 5,000 to 10,000 cycles per second.

Such alternators can be constructed with comparative ease, while an increase of their frequency of, say, nine times will gener-

* *Journal Inst. Elec. Engineers*, 52, p. 700.

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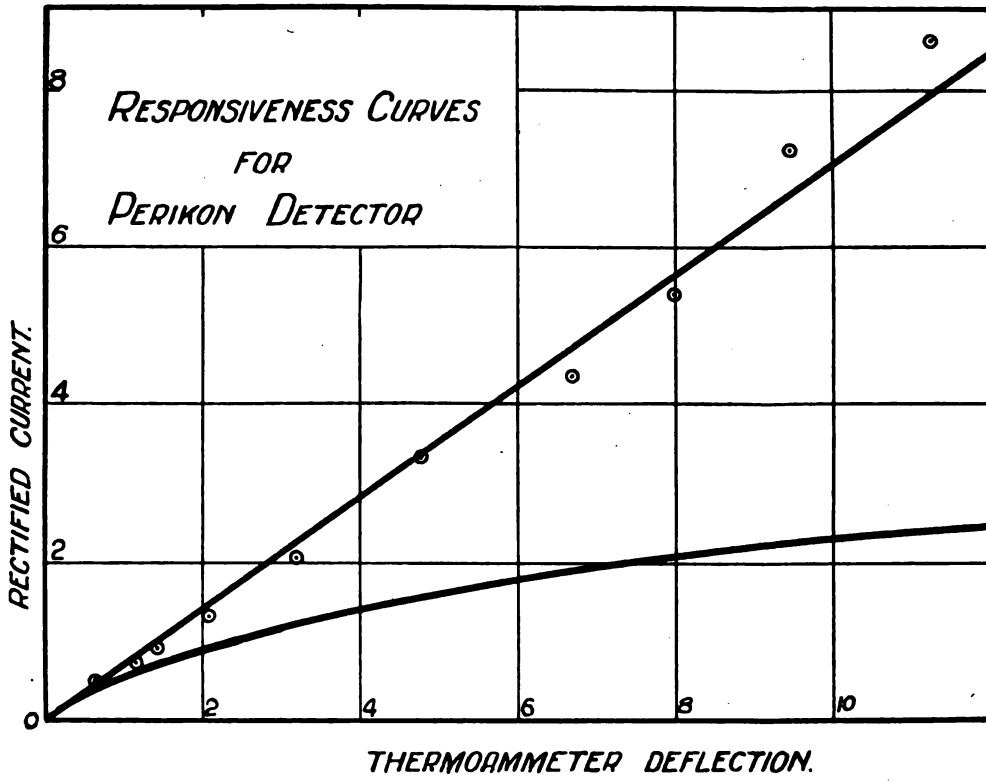

FIG. 16.

ally be found sufficient for long distance (long wave) wireless telephony; but, if necessary, a 27-fold increase, or more, may be used if desired for shorter wave-lengths.

MODULATION OF THE TRANSMITTED WAVES.

We have been considering up to the present the various means by which the required oscillatory energy may be generated. This leads us to the important question of how this energy is to be modulated in accordance with the speech waves. This is a matter that still affords one of the greatest difficulties in the development of the subject, although many attempts have been made towards its solution, some of which would seem to show considerable prospects of success.

In the first place the ordinary commercial carbon microphone is designed and constructed to carry only a fraction of an ampere, although experiments show that the commercial "solid back" type of transmitter is capable of carrying and modulating currents up to about 1 ampere or a little over. When larger currents have to be dealt with several such microphone transmitters may be connected in parallel, and arrangements made for them to be influenced simultaneously by the voice. It is generally inadvisable, however, to employ more than about five or six in this way, owing to inequalities in their operation causing the currents to be unequally divided between them, resulting in a loss in efficiency and in the purity of speech transmission,

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apart from the difficulty of arranging for them all to be equally operated upon by the sound waves. In any case, however, it is obvious that the ordinary carbon microphone is useless for anything except the smallest of stations in which the aerial current does not exceed a few amperes. A further difficulty arises from the fact that, because a microphone can *carry* the desired current without undue heating, it does not at all follow that it will be able to successfully *modulate* it, although when used on the ordinary telephone circuits it may be quite efficient. This arises from the different conditions of use, and, of course, applies equally to other forms of microphone as well as to the carbon microphones ; as in the wireless case we have in general a much greater voltage available in the aerial circuit (than in ordinary circuits), and hence a correspondingly greater resistance variation is necessary for successful operation. Hence a low resistance microphone, with correspondingly small resistance variation (when spoken to), may be quite useless as a transmitter, although it may be able to carry the required current quite easily. Hence it is often necessary to connect more than one microphone in series to obtain sufficient resistance modulation. Another difficulty that frequently arises when using commercial microphones not specially designed for use with high frequency currents is that of capacity currents within the microphone shunting a portion (often a large portion) of the current across the frame or other parts of the instrument without their passing through the resistance material at all. For this reason it is often necessary to remount the parts of commercial microphones on insulating supports and frameworks, if the best effects are to be obtained from them when they are used for modulating high frequency currents.

An improvement may often be effected under these conditions by coupling the microphone to the antenna circuit instead of inserting it directly in the circuit, as by this means the effective voltage in the microphone circuit may be easily varied to suit circumstances, while at the same time the effect of the microphone on the aerial circuit can be controlled at will.

It is for this reason that it is generally advisable when a number of microphones are in use at the same time to arrange them so that they can be easily connected in parallel, in series, or in series-parallel, so as to obtain the best results in any particular circumstances. On account of the above limitations of the ordinary carbon microphone many attempts have been made to employ some other microphonic material which shall be capable of carrying much heavier currents without undue heating, and at the same time of successfully modifying them according to the sound waves. Attempts have also been made to modify the carbon microphone so as to render it more suitable for the work that it is required to do, and at the same time to render it possible to employ water cooling.

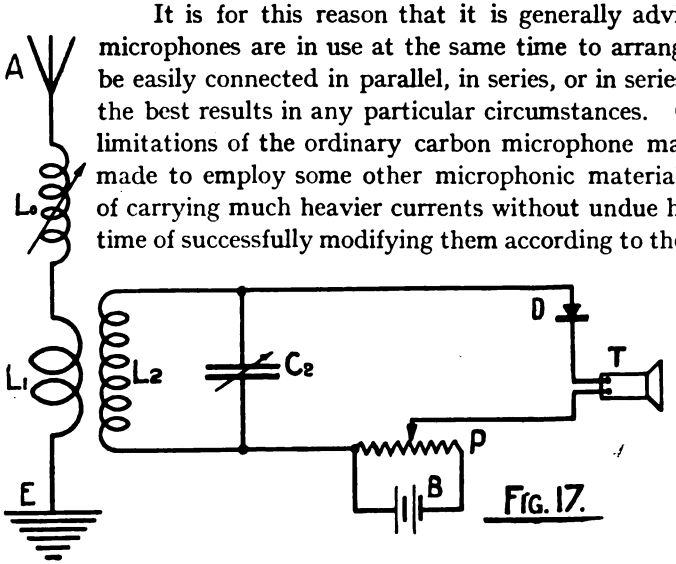

FIG. 17.

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An example of a microphone transmitter of this type is furnished by Dubilier's transmitting relay microphone.

A much more successful type, however, is that employing some liquid as the current carrying medium, as it is then possible to employ a continuous circulation by which the liquid can be kept cool, and as it is only carrying the current for a short period of time while it is between the microphone electrodes. Two well-known forms are Vanni's liquid microphone and Chambers's liquid microphone.

In Vanni's microphone a fine jet of acidulated water or other convenient electrolyte is allowed to impinge on to a slanting metallic plate which forms one electrode of the microphone. Another plate carried by the diaphragm is arranged just to dip into the stream of liquid as it falls on to the other fixed plate, thus leaving a small space between them, the thickness of which is varied by the motion of the diaphragm.

This diaphragm may be operated directly by the voice, or preferably electromagnetically from a local circuit containing an ordinary microphone transmitter and suitable cells. The microphone should be inserted in the aerial circuit, or circuit coupled to it, rather than in the main supply to the arcs, or other oscillation generator on account of the reduction of electrolysis, and polarisation troubles when the microphone is traversed by an alternating current.

In Chambers's microphone the diaphragm is arranged to form one of the electrodes, while the jet of liquid impinges on its under surface. Hence the vibration of the diaphragm varies the thickness of the film of liquid issuing from the jet, and hence varies the resistance, in a manner depending on the sound waves.

It is stated that this type of microphone gives a very good speech reproduction free from resonance effects from the natural period of the diaphragm, since the liquid in contact with the diaphragm forms a very efficient damping agency preventing such free vibrations.

More recently another type of liquid microphone has been patented * in which the resistance variation is affected by varying the amount of conducting liquid admitted into a stream of non-conducting liquid flowing past the microphone electrodes; but as far as I am aware no extensive tests have been made with it to examine its capabilities.

Another rather novel form of microphone suitable for wireless telephony which has been employed for communications over considerable distances is Mazi's carbon powder microphone, in which the microphone material is carbon powder, a stream of which is passed through the apparatus so as to keep it cool.

As another method of modulating the transmitted waves mention should be here made of the condenser microphones, in which the diaphragm is arranged to vary the capacity of a condenser by means of its vibration. This condenser is connected in the aerial circuit, and hence when its capacity varies with the sound waves the wave-length of the circuit will be altered and the aerial thrown in and out of tune with the other circuits of the transmitter (and receiver), and hence the strength of the transmitted waves will be varied by the movements up and down the resonance curve. This type of microphone has apparently not been applied to stations of any

* British Patent, 7922, 1914.

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but small power, so that its possibilities cannot very well be gauged, except in that one would expect that considerable difficulty would be experienced in designing such a microphone to have sufficient area and capacity to carry the large aerial currents and at the same time to have sufficient spacing between the opposite electrodes to withstand the voltage and yet be small enough for the motion of the diaphragm to have any appreciable effect on its capacity.

RECEIVING APPARATUS.

The receiving apparatus required for wireless telephony by means of ether waves differs very little from the ordinary receivers in common use for wireless telegraphy, and hence need not be considered very fully here. The circuit arrangements at the receiver are much as usual for the particular detector employed. As to the detector, the really essential feature is that its indications should be practically proportional to the energy received, otherwise the speech would be distorted. It must also of necessity be suitable for use with a telephone receiver.

The type of curve required is the straight line one there shown.

These considerations rule out practically all of the " coherer " type of detectors (apart from their relative insensitiveness compared with other forms), and we are left with magnetic detectors, crystals, and valves, and similar detectors.

Of magnetic detectors the most important is the well-known Marconi magnetic detector.

Among crystals most of the usual combinations are available, the most suitable being, perhaps, the " perikon " (or zincite-chalcopyrite), zincite-bornite, carborundum, etc. The usual connections may be employed.

In general it is found that the use of a fairly weak coupling is advisable in order to obtain purity of speech-transmission. Under the heading of valves we have the Fleming valve, the de Forest " audion," and other similar detectors.

The connections of the receiving apparatus for use with the valve are essentially the same as when a crystal is employed except for the addition of the cells for heating the valve filament.

With the audion type of detector containing a third electrode slightly different connections are required, although the main features are the same.

This brings us to a consideration of the use of amplifiers in receiving, a practice which has lately grown in favour for wireless telephone receiving, as by this means it is possible to employ very much less power at the transmitter for a given range, an important factor in the present stage of development of the transmitting apparatus.

The available amplifiers may be classified for our present purposes into :—

(1) Electromagnetic or microphonic type.

(2) Electron or vacuum amplifiers.

The former include such apparatus as the Brown telephone relay, the telefunken, and other sound intensifiers, etc., and are available only for use in conjunction with one of the forms of detector previously mentioned. The mode of operation of all the members of this class involves the employment of some form of microphonic contact or contacts (such as a carbon microphone, or the microscopic air-gap of Brown's relay), the resistance of which can be controlled by an electro-magnet

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through which is passed the " rectified current " from the detector.* Brown's relay, which may be taken as typical of this class, was described in a paper read before this Institution, and so need not be described in detail here.†

To the second class belong the vacuum amplifiers, in which use is made of the properties of cathode rays (streams of electrons) in a vacuum tube, as described above in connection with the vacuum oscillation generators. The " audion " and " pliotron " belong to this type. The Marconi Co. have also utilised amplifiers similar to the above in tests carried out with their apparatus by the Italian Navy in which distances of about 45 miles have been covered with an expenditure of energy at the transmitter of only 4 or 5 watts.

A Telephone System with Wireless Auxiliary

By FRANK C. PERKINS

THE accompanying illustration shows the electrical apparatus used in the wireless auxiliary to Pittsburg-Allegheny Telephone System. It is claimed that wireless is a valuable supplement to the Pittsburg and Allegheny Telephone Company as a distinct department of its business in Pittsburg, Pa.

There are eight branch stations established at points in Western Pennsylvania, Eastern and Central Ohio and parts of West Virginia, throughout the territory in which the company operates its telephone system, and trained operators, working the company's secret code, keep in daily touch with the big station in Fernando Street, Pittsburg.

It may be stated that the most distant station in the organisation is at Erie, Pa., a distance of nearly 200 miles. The need for the wireless became apparent when a storm of wind and sleet last winter threw down poles and wires over so wide an area that Pittsburg was almost completely cut off from the rest of the world for nearly a week. The telephone companies were paralysed for several days.

In this difficulty repair gangs were sent from all the towns in the district, but with no wires it was impossible to keep in touch with any of them, and reports, orders and requisitions for materials had to be made by messengers, and these had to depend wholly upon trains to get about from place to place.

On account of the loss of wire service the work of rehabilitating the telephone service was retarded for days. The wireless plan was then adopted, and a wireless organisation was formed among the employees and equipment for the nine stations was installed.

* The term " rectified " is used in the general sense to include the current yielded by the detector, whether or not it is a " rectifier " in the true sense of the word.

† *Journal Inst. Elec. Engineers*, 45, p. 590, 1910

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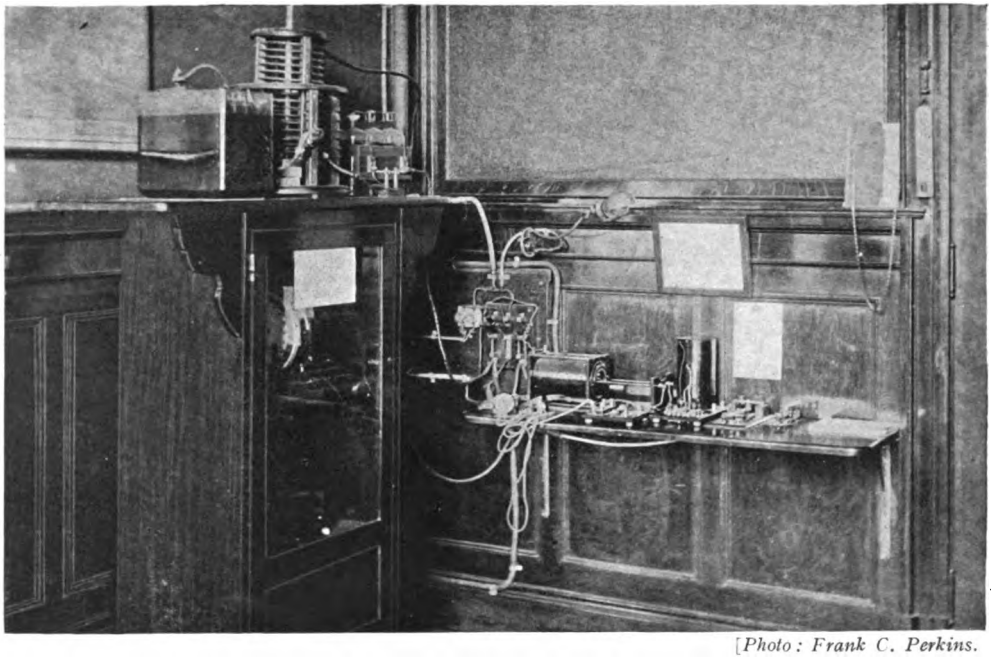

[Photo: Frank C. Perkins.

WIRELESS INSTALLATION OF PITTSBURG AND ALLEGHENY TELEPHONE COMPANY

In order to guard against unpreparedness in an emergency it was decided to keep the organisation in training by a certain amount of work every day, and the experience thus gained has been invaluable. Should another storm do the damage that was inflicted last winter the company can get into communication at once, and continuously, with every part of its system. The whole situation could be handled and directed right in the Pittsburg office and the innumerable delays of last winter obviated. Practically all the apparatus in the Pittsburg station was made in the company's shops in the Miller Building. All the transmitting apparatus, except the sending key, is enclosed in a sound-proof case.

It will be noted from the photograph that the receiving apparatus is placed on the shelf.

The Pittsburg and Allegheny wireless stations are used every night at ten o'clock to catch the detailed weather reports and forecasts sent out from the Government wireless station at Arlington, near Washington, and this wireless equipment has been of great value to the telephone system.

A Contrast in the Arrival of News of Victory.

News of the Jutland victory was published here forty-eight hours after the fight was over, and this brief delay contrasts rather markedly with the arrival of Trafalgar news, which took over a fortnight, and with that of Waterloo, which consumed four or five days in transit. The contrast between modern times with wireless facilities regularly available, and those, even of the very recent past, is marked indeed.

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Foreign and Colonial Notes

ARGENTINA.

Among the subjects discussed at the Pan-American Conference held at Buenos Aires in April last was the control of wireless telegraphy by the various Governments and connecting up of the ordinary telegraphic systems of the two continents. This is an important step, as the telegraphic services over the South American Continent have been miserably poor.

* * * * * *

CANADA.

According to the annual report of the Radiotelegraphic Branch of the Department of Naval Service for the fiscal year ending March 31st, 1915, there was an increase of 78 in the number of radio telegraph stations established in Canada and on Canadian ships during that year, divided as follows :—Government ship stations, 3 ; licensed ship stations, 18 ; licensed commercial stations, 8 ; licensed amateur stations, 48 ; licensed experimental stations, 1. The total number of stations in operation in Canada at that date was 247.

* * * * * *

NEW ZEALAND.

Wireless working in general is still very quiet, but with the winter signals are improving wonderfully, and stations 2,500 miles distant who have been unheard during the summer are now audible throughout the night. According to our contemporary, the *Katipo*, the Antarctic ship *Aurora* was heard at Radio, Wellington, and the same evening at Bluff and Hobart.

* * * * * *

UNITED STATES.

From the *Wireless Age* we learn that the Advanced Hamilton Radio Association of Hamilton, Ohio, has rather unusual and interesting ideas in regard to both organisation and qualifications. The Association is governed by an Executive Committee of three members. A new member is appointed at each meeting to take the place of the first member, who withdraws. There is no officer except the Secretary. Each charter member must possess the following qualifications :—Have an United States Government Wireless Licence, be skilled to send and receive at least 12 words a minute, and have at least two years' experience in wireless telegraphy.

* * * * * *

A plan is being considered in the state of Illinois to instal a powerful wireless apparatus in the State House at Springfield as part of the military equipment of the State. As suggested to the Governor, the antennæ would reach from the dome of the State House, 360ft. high, to the State power plant chimney stack when completed, which will be 200ft. high.

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Instructional Article

NEW SERIES (No. 11).

The following series, of which the article below forms the eleventh part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Determination of the Laws of Curves (*continued*).

78. The only other form of equation with which we shall deal in this way is that which may be represented by the general expression $y=ax^n$. In this case both a and n are constants.

Suppose, for example, we plot the curve of $y=3x^2$.

Tabulating:

$x=$	10	5	0	-5	-10
$y=300$	75	0	75	300	

Plotting these values (Fig. 62) we see that the curve is very far from being a straight line as, indeed, we should expect, having regard to the fact that the equation is one of the *second degree.*

Let us now modify our equation by taking the logarithms of both sides. Then, instead of $y=3x^2$ we get $\log y=\log 3+2 \log x$, *an equation of the first degree.*

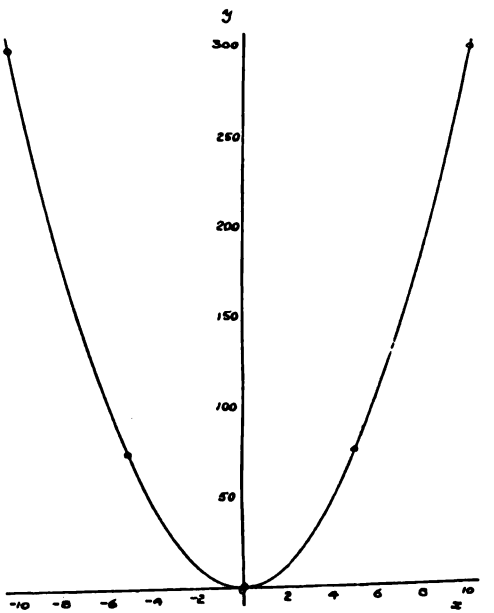

FIG. 62.

Tabulating for this new equation:

$x=$	10	8	5	2	1
$\log x=$	1	0·9031	0·6990	0·3010	0
$2 \log x=$	2	1·8062	1·3980	0·6020	0
$\log 3=$	0·4771	0·4771	0·4771	0·4771	0·4771
$\log y=2 \log x+\log 3=$	2·4771	2·2833	1·8751	1·0791	0·4771

Plotting the curve connecting *LOG x* and *LOG y*, we obtain Fig. 63. The important thing to notice is that we have now obtained a *straight line* curve.

From our previous work we know that the law of this curve is $y=mx+c$; where $c=0·4771$ and $m=\tan\theta=\frac{2}{1}=2$. In this particular case, however, since we have plotted $\log x$ instead of x, and $\log y$ instead of y, the law will be:

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$$\log y = m(\log x) + c$$
$$\text{or } \log y = 2 \log x + 0{\cdot}4771.$$

Now in the case of our general equation $y = ax^n$, we have for its new form $\log y = \log a + n (\log x)$, and so, instead of c we have $\log a$, and so

$$c = 0{\cdot}4771 = \log a, \text{ or } a = 2.$$

Finally, for m we have n, thus giving us $n = 2$.

Now we know that the equation

$$\log y = 2 \log x + \log 2$$

which we have found, can be changed into

$$y = 3x^2$$

by taking antilogs of both sides. Consequently, if we had started with the curve of Fig. 62 and had wanted to find its law, and we had then plotted the logarithms of x and y

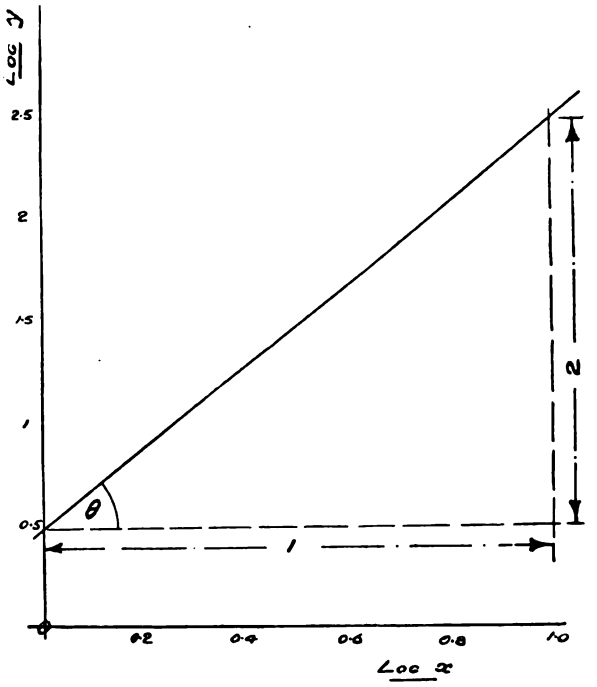

FIG. 63.

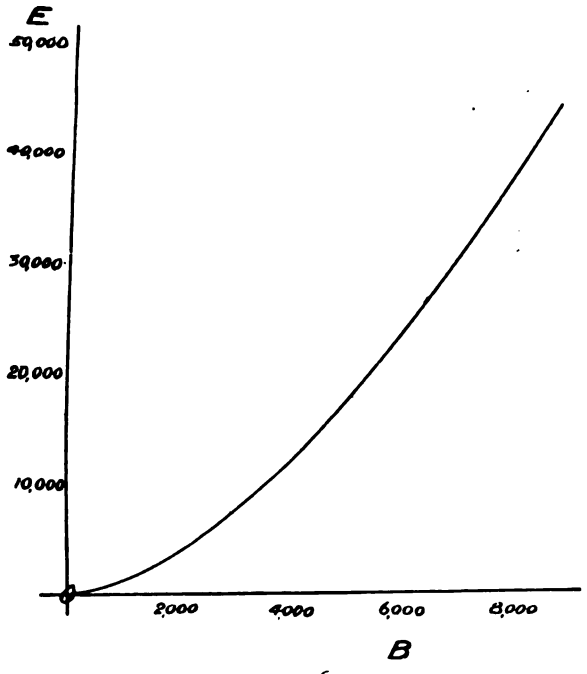

FIG. 64.

thus obtaining Fig. 63, we should in this way have found the law we required.

The situation, in brief, is as follows:

The type of curve whose law is easiest to find is the straight line. If, on plotting the results of an experiment we obtain a *curved* curve, it is worth while plotting the logarithms of the two quantities in the hopes that a straight line will result. If we do get a straight line we know then that the law is of the form $y = ax^n$, where a and n can be found from the logarithm curve.

Example.

The following table gives the hysteresis losses (E) for

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different values of the flux density (B) in particular sheets of transformer iron. Find the law connecting E and B:

B = 1,000 | 3,000 | 5,000 | 7,000 | 9,000

E = 1,262 | 7,380 | 16,600 | 28,400 | 42,400

Plotting, we obtain the curve of Fig. 64, which is obviously not a straight line.

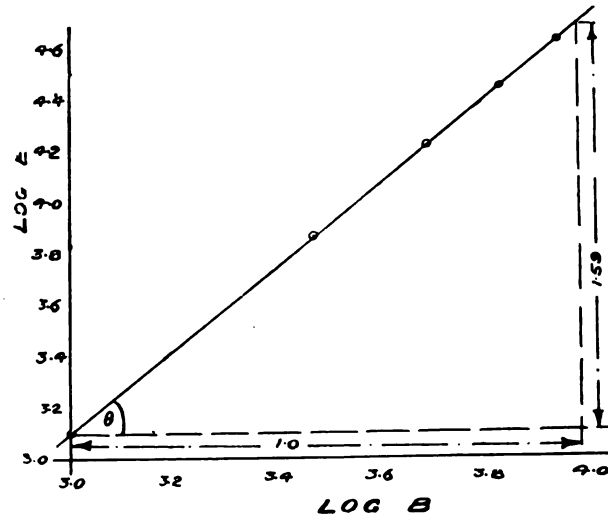

FIG. 65.

Now tabulate the log values:

B = 1,000	3,000	5,000	7,000	9,000
log B = 3	3·4771	3·6990	3·8451	3·9542
E = 1,262	7,380	16,600	28,400	42,400
log E = 3·1011	3·8681	4·2201	4·4533	4·6274

Plotting these values we obtain the straight line of Fig. 65. From this we get

$$m \text{ or } \tan\theta = n = \frac{1\cdot4311}{0\cdot9} = 1\cdot59.$$

Now from log B = 3·9 to log B = 3, the value of log E decreases from 4·5320 to 3·1011, or by 1·4311. Thus from log B = 3 to log B = 0 the value of log E will decrease further by

$$\frac{3\cdot0}{0\cdot9} \times 1\cdot4311, \text{ or by } \frac{4\cdot2933}{0\cdot9} = 4\cdot7703.$$

Therefore, the value of log E when log B = 0 will be

$$3\cdot1011 - 4\cdot7703 = -1\cdot6792$$

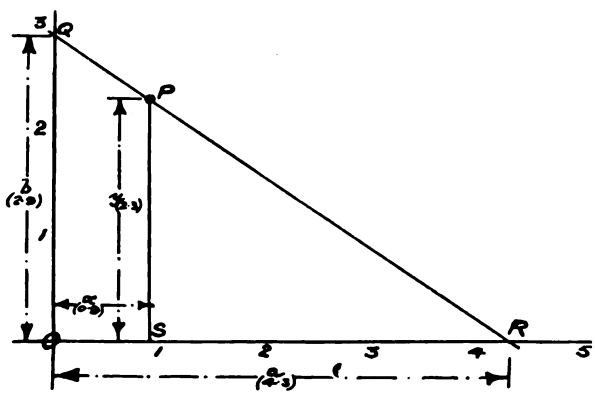

FIG. 66.

Thus log a = $-1\cdot6792$
= $2 + \cdot3208$

From this
a = antilog $(2 + \cdot3208)$
= 0·02093.

Therefore, the law of the curve of Fig. 65 is

log E = 1·590 log B − 1·6792,

and the law of the curve of Fig. 64, which is what we want, is

$$E = 0\cdot02093\ B^{1\cdot590}$$

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or, approximately, $E = \cdot 02\ B^{1\cdot 6}$. *Ans.*

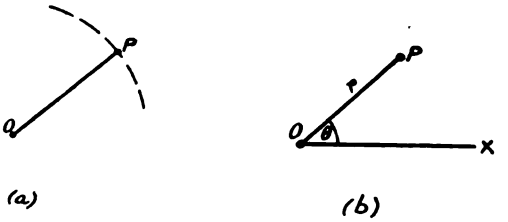

FIG. 67.

79. There is another method of dealing with straight line curves which is of interest. In Fig. 66 the straight line QR cuts the two axes at Q and R, making intercepts a and b along the x-axis and y-axis respectively, as shown. If now we take *any* point $P(x, y)$ on QR, we shall have found the law of the curve if we can find a *general* expression giving the position of the point P in terms of x and y together with some constants.

Draw the perpendicular PS as shown.

Now PS is parallel to QO, and so the ratio $\frac{PS}{QO}$ is equal to the ratio $\frac{SR}{OR}$, or

$$\frac{PS}{QO} = \frac{SR}{OR}$$

$$\frac{y}{b} = \frac{SR}{a} = \frac{a-x}{a}$$

$$= 1 - \frac{x}{a}$$

Therefore $\frac{x}{a} + \frac{y}{b} = 1$.

This expression gives the law of the curve QR in the *Intercept Form*, so called because the only terms involved, in addition to the indispensable x and y, are the lengths of the intercepts a and b.

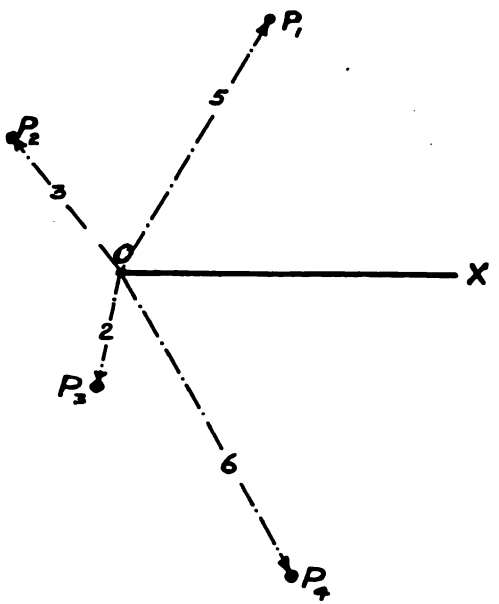

FIG. 68.

In Fig. 66 we have $a = 4\cdot 3$
$b = 2\cdot 9$.

Thus the law is $\frac{x}{4\cdot 3} + \frac{y}{2\cdot 9} = 1$.

As a check on this let us take the values of x and y at the point P. Here $x = 0\cdot 9$ and $y = 2\cdot 3$.

Inserting these values in $\frac{x}{4\cdot 3} + \frac{y}{2\cdot 9}$, we get

$$\frac{0\cdot 9}{4\cdot 3} + \frac{2\cdot 3}{2\cdot 9} = 0\cdot 209 + 0\cdot 793$$

$= 1\cdot 002$, or practically 1, which is correct to within our present limits of accuracy.

Polar Co-ordinates.

80. The system of rectangular co-ordinates we have been using to plot these curves is not the only system of its kind.

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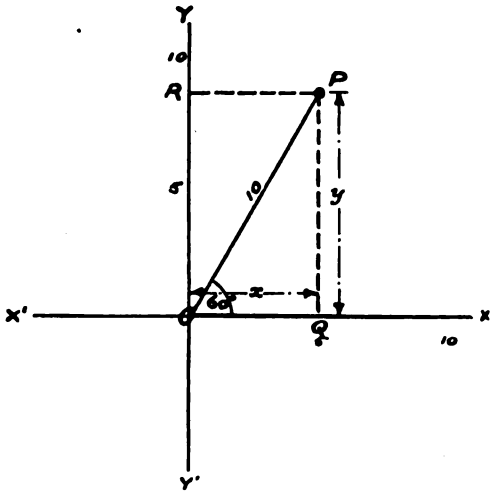

FIG. 69.

OP is the *radius vector* (r), and the angle *XOP* is the *vectorial angle* (θ). Thus the point *P* can be written as (r, θ).

In Fig. 68 we have the points:

P_1—(5, 60°)
P_2—(3, 130°)
P_3—(2, 260°)
P_4—(6, 300°) as shown.

81. It is quite a simple matter to change from one system of co-ordinates to another.

In Fig. 69 we have the point *P* (10, 60°).

Produce *XO* indefinitely to X^1, and draw YOY^1 perpendicular to XOX^1, thus providing the necessary two axes for the rectangular co-ordinates.

Draw perpendiculars *PQ* and *PR* on to XX^1 and YY^1 respectively.

From an inspection of the diagram it will be quite obvious that, if (x, y) are the rectangular co-ordinates of *P*, then $OQ=x$ and $QP=y$.

Now $OP=10$, and angle $QOP=60°$.

In Fig. 67 (*a*) we have a point *P* situated at some definite position relative to the point *O*.

Obviously, if we know only the distance from *P* to *O*, we do not know enough to enable us to specify the position of *P*. If, however, we draw a line *OX* (Fig. 67 (*b*)) from *O*, and use this as a fixed reference line, then if we know the distance *OP and also the angle XOP* we can fix exactly the position of *P*.

This is the system known as that of *Polar Co-ordinates*, where *O* is the *origin* or *pole* (as in the rectangular system), and *OX* the *initial line* is a horizontal line drawn from *O* towards the right-hand side of the paper.

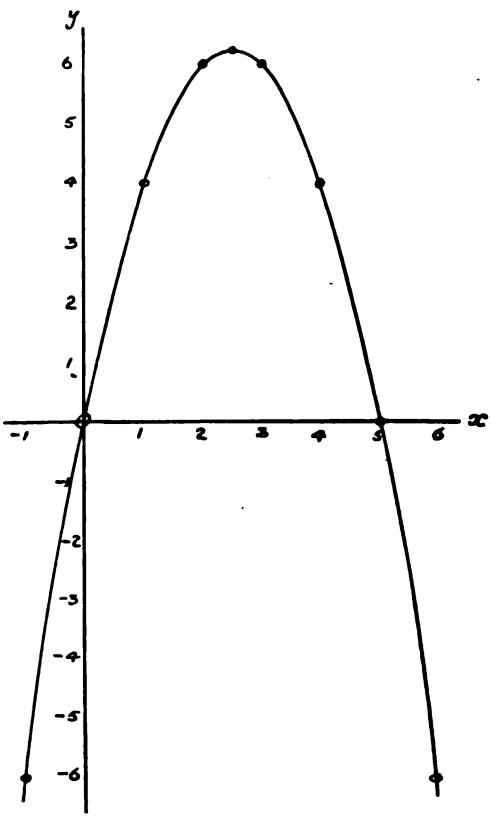

FIG. 70.

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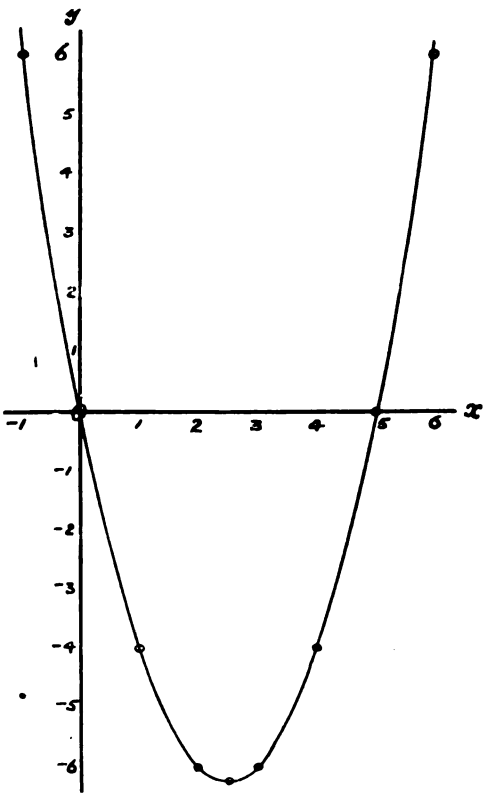

FIG. 71.

Therefore $x=OQ=OP\cos QOP$
$=10\cos 60°$
$=10\times\frac{1}{2}=5$
and $y=QP=OP\sin 60°$
$=10\times\frac{\sqrt{3}}{2}=8{\cdot}65.$

Thus the rectangular co-ordinates of P are (5,8·65).

The reverse operation, that of changing from rectangular to polar co-ordinates, is equally simple.

Suppose we had been given the point P (Fig. 69 again) as (5,8·65), then we see that the radius vector

$$P=\sqrt{x^2+y^2}$$
$$=\sqrt{(5)^2+(8{\cdot}65^2)}$$
$$=\sqrt{25+75}$$
$$=\sqrt{100}=10.$$

Also the vectorial angle

$$\theta=\tan^{-1}\left(\frac{y}{x}\right).$$

$\left[\text{The angle whose tan is } \frac{y}{x}\right].$

$$=\tan^{-1}\frac{8{\cdot}65}{5}$$
$$=\tan^{-1}1{\cdot}73=60°.$$

Thus P is the point (10,60°) as we know.

Maxima and Minima.

82. Let us plot the curve for

$$y=5x-x^2$$

Tabulating—

$x=$	-1	0	1	2	3	4	5	6
$y=$	-6	0	4	6	6	4	0	-6

From these figures, without plotting the curve, we see that y attains a maximum at the value $x=2\frac{1}{2}$. At this point $y=6\frac{1}{4}$.

The curve (Fig. 70) has its highest point, or *maximum*, as would be expected, at $(2\frac{1}{2}, 6\frac{1}{4})$.

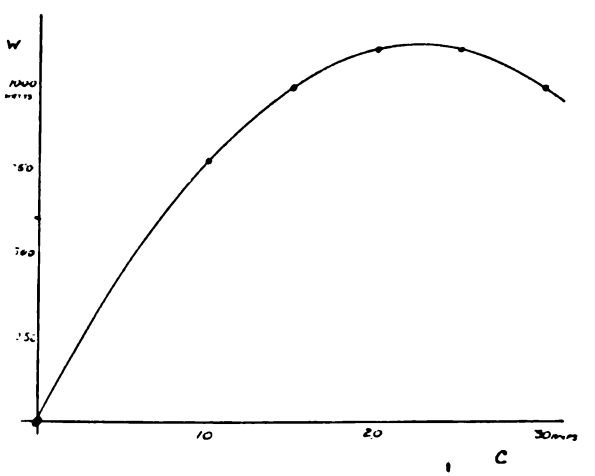

FIG. 72.

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If now we plot $y=x^2-5x$ we get a similar but reversed phenomena (Fig. 71).

Tabulating—

$x=$	-1	0	1	2	3	4	5	6
$y=$	6	0	-4	-6	-6	-4	0	6

In this case we get the point $(2\frac{1}{2}, -6\frac{1}{4})$ as a *minimum.*

Thus, if we have two interdependent quantities, we can, by plotting their relationship in the form of a curve, find the values of each for which either is a maximum or a minimum.

Example.

The power given to an electrical circuit by a dynamo is $W=IE-I^2r$, where

W=power (in watts).
I=current (in amps.).
E=e.m.f. (in volts).
and r =internal resistance of dynamo (in ohms).

If $E=100$ volts and $P=2\cdot2$ ohms, find the current at which the power is a maximum.

Tabulating—

$C=O$	10	15	20	25	30 amps.
$W=O$	780	1,005	1,120	1,125	1,020 watts

The curve (Fig. 72) shows that W is a maximum when $C=22\cdot5$ amps., and its value there is 1,140 watts, or 1·14 kw.

83. A very important type of curve is obtained by plotting sin θ (vertically) against θ (horizontally).

Tabulating—

$\theta=0°$	30	60	90	120	150	180	210	240	270	300	330	360
$\sin\theta=0$	·50	·866	1	·866	·5	0	$-\cdot5$	$-\cdot866$	-1	$-\cdot866$	$-\cdot5$	0

In this case we obtain, of course, the well-known *Sine Curve* (Fig. 73). The maximum and minimum values of sin θ occur at 90° and 270° respectively, the values being $+1$ and -1. This curve, if plotted on for values of θ greater than 360°, will repeat itself indefinitely. The positive and negative "loops" of the curve are identical in everything except sign.

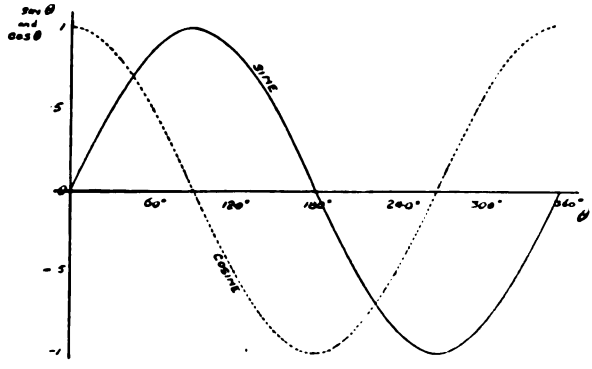

FIG. 73.

This curve is of the utmost importance in the study of alternating currents, as the alternating e.m.f. produced by the alternator (and therefore the current in the external circuit) is assumed to vary in such a way that, plotting current against time, a sine curve is the result.

This assumption is only strictly true in certain unlikely cases, but it is adhered to on account of the way in which it

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simplifies dealing with A.C. problems. Also it has been found that such a *wave-form* is a desideratum, and so machines are nowadays designed with such a wave-form in view.

Fig. 73 shows also (dotted) a *cosine curve*. This curve is exactly similar to the sine curve, except that it is displaced horizontally through 90°. The maximum and minimum values of either curve occur at the same angles as the zero values of the other.

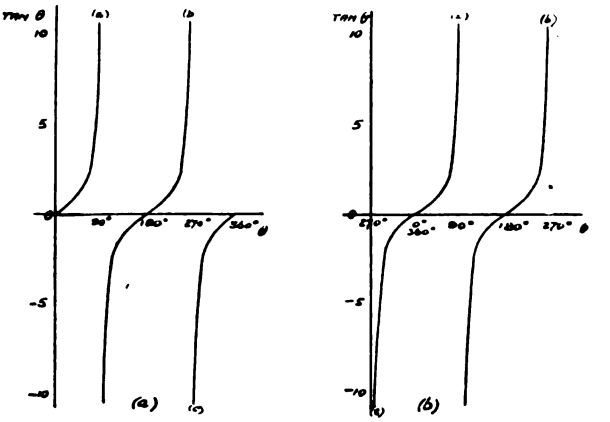

FIG. 74.

It should be noted that in any curve which has both maxima and minima, these maxima and minima *must* always follow one another alternately. The reason for this will be seen at once on attempting to draw a curve which has, say, two successive maxima with no minimum between.

The *tan curve* [Fig. 74(*a*)] is quite different to the sine and cosine curves. At first sight it would seem to consist of three separate parts (*a*), (*b*) and (*c*). Fig. 74 (*b*) shows, however, that (*a*) and (*c*) will join at 0° or 360°, and again the two parts (*a*,*c*) and (*b*) join on to one another *at infinity*, and so make one continuous curve.

Contract Note

A representative of the Carranza Government of Mexico in San Francisco has closed a contract with the Marconi Wireless Telegraph Company of America for the supply of four 5-kilowatt 500-cycle quenched gap wireless sets. These are to be installed in plants which the Mexican Government proposes erecting at various points along the Mexican coast. How far this arrangement will be affected by the troubles apparently now brewing between America and Mexico, it is impossible to say.

Share Market Report

LONDON, *June 12th*, 1916.

The appreciation in share values has continued during the past month, especially towards its close, the annual report of the Marconi International Communication Co. (see p. 328) being considered most favourable. The expansion of the gross and net receipts of this shows what may be expected when the present war comes to an end.

Marconi Ordinary, £2 8s. 9d.; Marconi International Marine, £1 11s. 3d.; Marconi Preference, £2 1s. 3d.; American Marconi, 14s. 6d.; Canadian Marconi, 8s.; Spanish and General Wireless Trust, 6s. 3d.

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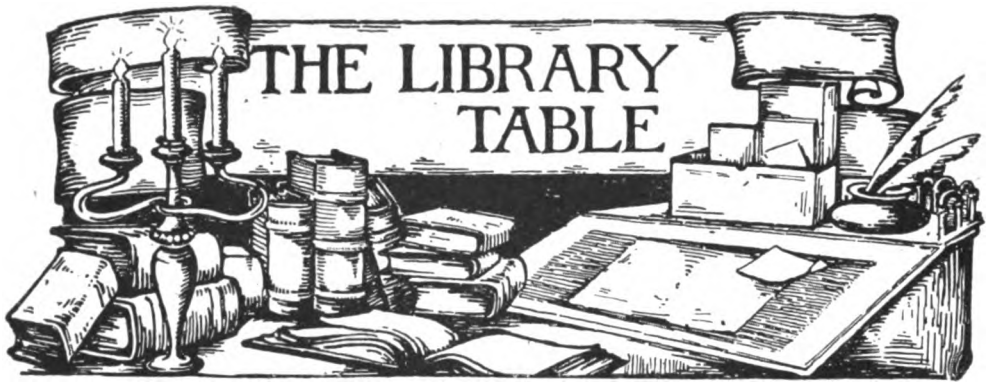

"ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM." By Sylvanus P. Thompson. London: Macmillan & Co. 4s. 6d.

This volume is now so well known wherever the English language is spoken that any words of praise which we might utter concerning it would be superfluous. The new edition bears evidence of considerable revision and rewriting, and, as Professor Thompson says in the Preface, progress in the development of the industrial application of electricity has been so great in the past decade, that it has been necessary to remodel the latter half of the book.

In the article devoted to the principles of wireless telegraphy, we think it would have been well if Professor Thompson had shown how much of Senatore Marconi's success depended upon his invention of the earthed antenna. It would also have been well to point out how greatly superior Marconi's coherer was to any which had previously been used. As it is, it is difficult to learn from this article by what means the great inventor succeeded in removing ether wave signalling from a laboratory into the realm of practical commercial work. We thought we had long since passed the day of the belittling of the famous Italian in such a work as this.

In the section entitled Radio Telegraphic Transmitters, it is mentioned that the aerial conductors are led down through a tuning inductance coil and through the secondary of an oscillation transformer. This being so, we think the student will be confused by the diagrams of aerials which have no inductance coil, but a spark gap in the earth leads. This is clear enough to those who understand "plain aerial" transmission, but unfortunately this is not mentioned in this part of the text.

We next find articles devoted to the Arrangement of Transmitting Circuit, Coupling, Quenched-Spark and Oscillating Arc systems, Radio Telegraphic Receivers, Detectors, Sending and Receiving, Wireless Telephony, and Other Suggestions for Telegraphing without Wires. The treatment, of course, is not intended to be at all thorough, and therefore we cannot criticise certain faults of omission. We must, however, draw attention to a sentence in "Radio Telegraphic Receivers," which reads:—"Tuning is not necessary for small installations, though it is always advisable." It is not at all clear what is meant by this.

A welcome chapter is that devoted to the Electron Theory of Electricity, a subject on which Professor Thompson is in an excellent position to write. The other portions of this famous book are so well known that we scarcely need detail

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them here. The new edition contains no less than 743 pages and is, as usual, well printed and admirably illustrated. As a textbook for schools, the volume is admirable, and we trust that the few points criticised above will not be overlooked in the preparation of further editions.

* * * * * *

"How to Make Low-Pressure Transformers." By Prof. F. E. Austin. Published by the Author at Hanover, N.H. 2s. net.

In a recent issue we had pleasure in reviewing a similar work by the same author on *Making and Operating High-Pressure Transformers*. This, the companion volume, has now run into a second edition, a fact which affords us no surprise in view of the practical nature of its contents. The transformers here described are designed for use on ordinary house lighting mains, where the pressure is 110 volts, or less, and the frequency about 60-cycles. They may be used for a variety of purposes, such as bell ringing, experimenting, running small low-pressure lamps, operating sparking devices for petrol engines and a number of other uses. In the United States electric bells are frequently rung by means of such transformers, in this way avoiding the use of cells, which sooner or later exhaust themselves. In this country for some reason or other such transformers have not come into extensive use, and this little book should assist in popularising them.

* * * * * *

"The Book of Wireless." By A. Frederick Collins. New York and London: D. Appleton & Co. 3s. 6d. net.

We do not know whether to welcome this volume or not. It is written by an American for Americans, with the idea of teaching small boys how to build wireless stations. The type of amateur for which the volume caters is one with whom we have little sympathy, i.e., the boy with no theoretical knowledge who erects a crude wireless plant, and, obsessed with the idea of having some "fun," plays with the key from morn till night. Such experimenters are a nuisance to everybody, and are the means of bringing down upon the serious experimenter, be he youthful or of mature age, those trying restrictions which do so much to hinder real progress. In America, there are unfortunately thousands of these irresponsible dabblers, and it is lucky for the sensible investigator that they soon tire of their new toy. We tremble when we think what would happen in this restricted island of ours if in peace time boy enthusiasts were allowed to follow out the instructions given in this book for building a transmitter using half a kilowatt! Luckily the Post Office will not permit it.

The volume is divided into three parts, Part I. showing how to erect and operate a small plain aerial wireless outfit consisting of ½-inch spark coil, four dry cells, a key and aerial and earth, the receiver being merely a crude coherer in series with the aerial. It is to be remarked that the experimenter is told to build his transmitter and receiver first and to learn the Morse code afterwards!

Part II. describes what is termed "A Long Distance Wireless Set," with a crude ½ kilowatt transformer, six Leyden jars, an auto-jigger, aerial switch and transmitting key. There are no inductive chokes in series with either the primary or secondary of the transformer. Further, the safety of the set is not improved by the suggestion earlier in the book that the ground lead should be connected to the *gas* or water pipe. A small boy using a ½ kilowatt set connected to a 110 volt house

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main, with no protecting chokes and the earth lead connected with the gas pipe, is likely to have an early opportunity of testing the Heaviside Layer theory.

Although the young experimenter is presumed to have no previous knowledge of wireless the theory of the subject is almost ignored. Only one other portion of the book calls for special comment, and that is the list of definitions and terms on pages 206 to 214. They are not very helpful and in some cases quite wrong. We learn for the first time that "adjustable" means (1) To change by steps and (2) a word interchangeably used with *varied*; that mica is a transparent material sometimes called isinglass; and that "One horse-power equals 33,000 pounds, raised 1 foot in 1 minute." The user of a ½-inch spark coil run off four dry cells as described in the earlier portion of the book will be interested in the definition of "Low Pressure Circuit." This reads as follows:—"The circuits of the generator and primary coil of an induction coil or a transformer. The pressure in these circuits may range from 110 to 220 volts."

A number of errors are scattered throughout the book, and some of them should not have passed the proof-reader. Thus on page 39 the Morse characters S.N. are labelled S.B., and on page 104, figure 127, entitled "Wiring Diagram of Reception With Potentiometer" should read: "Wiring Diagram of Receptor Without Potentiometer." Figure 54, entitled "Electric Waves thrown off by Aerial," is quite inexcusably wrong.

We cannot leave this book without quoting the following gem from the preface:—"To be a wireless boy and make your own apparatus is to have the kind of stuff in you of which successful men are made—men who, if they were shipwrecked on a desert isle at daybreak, would have something to eat by noon, a spring bed to sleep on by night, and a wireless station the next day sending out S.O.S. to ships below the horizon for help. All you need to do to become a member of the great and growing army of wireless boys is the desire to own a station and the rest is easy."

Yes, it is easy, but . . . . !

* * * * * *

"AIR WAR: HOW TO WAGE IT." By N. Pemberton Billing. London: Gale & Polden, Ltd. 1s. net.

One of the most annoying characteristics of modern business and social existence is the constant necessity for enunciation of the obvious. The little volume published by Mr. Pemberton Billing, under the title of *Air War and How to Wage It*, forms a case in point. The author states in his Preface that he has "only attempted to deal with the main principles of the problem and the method of working them." That the British people were unprepared for war is obvious; that their Government in this, as in all other respects, was—as ever—waiting to be pushed on by the people, is more obvious still. So also is the desirability of a secret service air chart and of the orders which might be founded upon it. The various other desiderata and plans outlined throughout the volume bear the same stamp. At first the practised reader can scarcely avoid a feeling of irritation at the obviousness of it all. But the question then arises:—"Is this little book, therefore, superfluous? Should we be where we are to-day, if it were needless to enunciate the obvious?"

NOTE.—*Any of the above books will be forwarded by return of post upon receipt of remittance covering cost of book and postage, by the Wireless Press, Ltd., Marconi House, Strand, W.C.*

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Personal Notes

The following paragraph from our contemporary, *The Faraday House Journal*, will perhaps be of interest to members of the Marconi Company's staff :—

" On the outbreak of war, Captain C. E. Prince, being in charge of a wireless " section of the Westmorland and Cumberland Yeomanry, was mobilised automati- " cally. As he was the co-designer of the wireless set used by this section he devoted " himself to improving the design. When he left to join the Royal Flying Corps " several notable improvements had been introduced and the whole set was mounted " on motor cars. Captain Prince is now in charge of the technical and experimental " departments of the Wireless School at Brooklands, and his duties occasionally entail " visits to the Front. The school elects and trains the wireless flying officers, and " several Faradians have already qualified in it. In addition, the school examines " and gives the final polish to the many operators who are being instructed in London. " We are looking forward after the war to describing some of Captain Prince's many " inventions. We do not agree with him, however, that he is absolutely devoid of the " mathematical faculty. In fact, the particular faculty developed by the great mathe- " maticians overlaps very considerably that developed by great physical inventors."

* * * * * *

The Royal Humane Society recently awarded a medal to Hon. Lieut. and Quartermaster J. W. Price, R.A.M.C., for his gallantry at the sinking of the *Royal Edward* in August last, when at great personal risk he saved the Marconi operator, E. W. Dyer, who had a fractured leg and dislocated shoulder, and was powerless to help himself.

* * * * * *

Our readers will be interested to learn that at the Lord Mayor's Dinner to the Delegates to the Russian Council of Empire and the Duma, which took place at the Mansion House recently, were Sir Edward Grey, Lord Reading (brother of Mr. Godfrey Isaacs, the Managing Director of the Marconi Co.), Mr. Kipling and Senatore Marconi.

* * * * * *

A luncheon was recently given to Mr. Walter Behrens, who acted as Honorary Secretary to the Commercial Committee of the House of Commons during the Congress of the Allied Parliaments. Sir John Randles presided, and amongst other notabilities we find the names of Lord Rotherham, Colonel Pryce-Jones, the Hon. B. R. Wise and Senatore Marconi.

* * * * * *

We beg to offer our congratulations to Able Seaman J. W. H. Bollan, of the Royal Naval Volunteer Reserve, who has received the Distinguished Service Medal for gallantry. He is one of the volunteers who went to the Mediterranean on *H.M.S. Queen Elizabeth*, and offered himself for service at the wireless station at Lancashire Landing in Gallipoli, where he remained until the evacuation.

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Company Notices

The Marconi International Marine Communication Co., Ltd.

Directors' Report, Balance Sheet, and Profit and Loss Account for the Year ending December 31st, 1915

It affords satisfaction to the Directors to inform you that the Company's business continues to show substantial expansion.

The net profit for the year amounts to £63,630 2s. 8d., after deducting the sum of £29,281 5s. 7d. for depreciation and debenture interest, compared with a net profit of £55,668 1s. 1d., for the preceding year. Notwithstanding the considerable decrease in passenger traffic during the past year and the necessary restrictions in respect of private messages at sea, the revenue from ships' telegrams, subsidies, etc., amounted to £208,899 14s. 2d., a substantial increase over the year 1914, when the figures were £175,021 1s. 10d. This increase is mainly due to the greater number of ships installed with wireless apparatus.

The number of telegraph stations owned and worked by the Company as public telegraph stations on the high seas increased from 875 at December 31st, 1914, to 1,008 at the end of December, 1915. The organisation of this Company, together with that of its associated companies, with a total of some 2,300 mercantile vessels fitted with Marconi telegraph stations, has continued to render inestimable service. The amount of the Profit and Loss Account now stands at the sum of £75,602 1s. 1d., including the sum of £11,971 18s. 5d. carried forward from the preceding year. The Directors have pleasure in recommending the payment of a final dividend for the year 1915 of 7½ per cent., which, with the interim dividend of 5 per cent. paid on February 1st, 1916, will make 12½ per cent. for the year, the total amounting to the sum of £38,260 10s. The losses sustained in consequence of attacks upon the mercantile fleet during the latter part of 1914, and those incurred during the year 1915, have been debited to Profit and Loss Account of the past year. Therefore the £10,000 which was placed last year to the credit of a Special Reserve Account to meet any losses arising from this cause remains intact, and it is now proposed to transfer this sum, together with the Share Premium Account, to a General Reserve Account, which will then stand at the sum of £27,639 14s. 3d.

The continuous growth of the Company's business, and the large number of additional telegraph stations on board ships, which are being installed year by year without the issue of additional capital, renders it prudent to carry forward the substantial balance of £33,841 11s. 1d., after providing the sum of £3,500 for the redemption of debentures. It will be observed from the figures given above that during the year under review there has been a net increase of 133 stations, representing a substantial capital outlay for which it would have been impossible to provide without raising additional capital had it not been for the policy of prudently husbanding the cash resources of the Company.

The balance carried forward will also serve to meet the Excess Profits Duty, which must exceed the sum of £8,095 8s. 6d., the amount payable under this head for the year 1914.

The Amalgamated Wireless (Australasia) Limited, in which this Company is interested, has paid a dividend of 6 per cent. in respect of the year ending June 30th, 1915.

The retiring Directors are Senatore Guglielmo Marconi and Mr. Alfonso Marconi, who being eligible, offer themselves for re-election.

The Auditors, Messrs. Cooper Brothers & Co., also retire and offer themselves for reappointment.

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THE MARCONI INTERNATIONAL MARINE COMMUNICATION CO., LTD.

BALANCE SHEET, DECEMBER 31, 1915

Dr.	£ s. d.	£ s. d.	Cr.	£ s. d.
To CAPITAL—			By PLANT, APPARATUS, FURNITURE AND STORES	255,131 9 0
Authorised.			*Note.*—Owing to the war it has not been possible to obtain certified Inventories for Apparatus and Stores amounting to £51,154 2s. 6d. The balance, £203,977 6s. 6d., has been certified by representatives of the Company.	
350,000 Shares of £1 each	350,000 0 0		By CONSIDERATION FOR LICENCE AND RIGHTS AND SHARES IN ASSOCIATED COMPANIES	219,381 11 7
Issued.			*Note.*—The Licence and Rights are subject to the provisions of five Agreements between this Company and five Associated Companies, under which this Company received Shares in Associated Companies for this Company's rights in Canada, Australasia, Argentina, Uruguay, and all European Countries and their Dependencies except Great Britain and Ireland and Italy.	
306,084 Shares, fully paid		306,084 0 0	By DEBTOR BALANCES	60,707 11 8
To 6,078 5½ PER CENT. 1ST MORTGAGE DEBENTURES OF £20 EACH		121,560 0 0	By DEBENTURE DISCOUNT	12,915 15 0
To RESERVE FOR REPAYMENT OF DEBENTURES		8,810 0 0	By CASH AT BANKERS AND IN HAND	45,416 3 4
To SPECIAL RESERVE FOR WAR CONTINGENCIES		10,000 0 0	By LOAN AGAINST SECURITIES	12,000 0 0
To RESERVE ACCOUNT		17,639 14 3		
To CREDITOR BALANCES		65,856 15 3		
To PROFIT AND LOSS ACCOUNT—				
Balance as per last account, December 31st, 1914	64,855 14 11			
Deduct—				
10 per cent. Dividend for 1914 ..£30,608 8 0				
Reserve for Repayment of Debentures .. 3,500 0 0				
Special Reserve for War Contingencies .. 10,000 0 0				
Additional Directors' Fees for 1914 .. 1,000 0 0				
Excess Profits Duty .. 8,095 8 6				
	53,203 16 6			
	11,651 18 5			
Amount taken from Reserve to redeem 16 Debentures ..	320 0 0			
	11,971 18 5			
Add—				
Balance of account for the year ending Dec. 31st, 1915 ..	63,630 2 8			
		75,602 1 1		
		£605,552 10 7		£605,552 10 7

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING DECEMBER 31, 1915

Dr.	£ s. d.	Cr.	£ s. d.
To SALARIES AND DIRECTORS' FEES	16,062 6 5	By SHIPS' TELEGRAMS, SUBSIDIES, NEWS SERVICE, RENTALS AND SUNDRY RECEIPTS	208,899 14 2
To GENERAL CHARGES, DIFFERENCE IN EXCHANGE AND INCOME TAX	17,221 11 1	By TRANSFER FEES	27 5 0
To EXPENSES OF SHIP TELEGRAPH STATIONS, including depreciation and loss of Plant and Apparatus	105,665 12 10		
To DEBENTURE INTEREST	6,347 6 2		
To BALANCE CARRIED TO BALANCE SHEET	63,630 2 8		
	£208,926 19 2		£208,926 19 2

GODFREY C. ISAACS, *Director.*
H. RIALL SANKEY, *Director.*

REPORT OF THE AUDITORS TO THE SHAREHOLDERS.

We have audited the above Balance Sheet with the books in London and accounts from Rome. We have obtained all the information and explanations we have required, and in our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs according to the best of our information and the explanations given to us and as shewn by the Books of the Company.

COOPER BROTHERS & CO., *Chartered Accountants* } *Auditors.*

LONDON, *June 2nd*, 1916.

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Pastimes for Wireless Operators

III.—The Study of Foreign Languages.

By "REDAX."

No one questions the advantage of a knowledge of foreign languages. To the wireless operator such knowledge is particularly valuable, for it enables him to reap benefits from his travels abroad which are denied to his monolinguistic *confrères*, and affords an asset frequently realisable in hard cash.

Take six senior men, equally experienced in wireless work and all well qualified to shoulder the responsibility of a land station. Supposing a vacancy with a good salary occurs in, say, South America—a country, by the way, with vast "wireless" possibilities—which of the men will most likely be chosen? Of course the man who knows Spanish! Yet few operators have even a passing acquaintance with this tongue.

Most men are ambitious to tak echarge of a land station after a few years at sea; they do not wish to remain marine operators all their lives. For this reason it behoves them to look carefully into their qualifications, to take stock of themselves and sum up their chances in the competition which invariably arises when good positions go vacant. Technical knowledge, skill in operating, business ability and tact all count, but the accomplishment which most often turns the scale in the favour of the successful candidate is an acquaintance with the language of the country in which the position is offered.

The two languages of the greatest use to operators are French and Spanish. French because it is practically an international tongue, and Spanish since it is the language most widely spoken in the great South American continent, where, as we have hinted above, wireless is destined to play such an important part in the future.

French, of the two, is perhaps the most generally useful, and should be acquired even at the sacrifice of the greater portion of one's spare time for a year or two. Abroad, where languages are studied with a seriousness only rivalled in this country by the devotion of our public schools to sport, no man considers his education even tolerably complete until he is able to converse fluently in this tongue. Even in Turkey, where one would scarcely expect to find a high level of education, the railway booking clerk and the wayside café proprietor invariably speak French, or at least can understand the gist of a conversation.

As a "stepping-off point" from which to progress to the study of other foreign tongues French is without a rival. Once it has been mastered, Spanish, Portuguese and Italian will lose their formidable appearance, and the operator will be well on the way to become a linguist. The social advantages accruing from the knowledge of this language are also not to be despised.

Much of what we have written is perhaps obvious—or should be—and thus often we find that, awaking to the advantages of linguistic knowledge, an operator will purchase a French or Spanish grammar. But of a hundred who start in this

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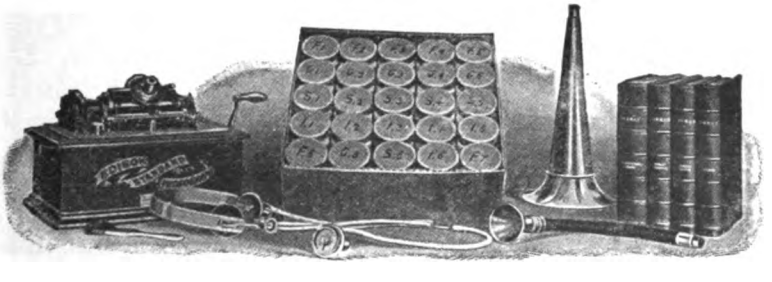
way scarcely ten achieve their aim, for enthusiasm soon evaporates and after all hard work is seldom voluntarily undertaken.

In the teaching of languages we in this country are unfortunately far behind our Continental friends, although of recent years considerable improvement has manifested itself. With a tenacity unintelligible to those acquainted with modern methods we cling to the unnatural and stultifying grammatical method, with the result that whilst a boy on leaving school knows more than a Frenchman himself about the moods and tenses of the verb "to give," yet he can scarcely give orders to a *cocher* to drive across Paris from one terminus to another.

By far the easiest and most practical method of learning any language is to follow closely the line taken by a child in acquiring its mother tongue. The toddler in the nursery never worries its head about nouns, adjectives and verbs, but simply keeps its eyes wide open and learns to attach simple names to beings and objects with which it comes into contact between waking and bedtime. "Mummy" and "daddy" come first, then perhaps "nanny." Next sundry bumps and tumbles bring such words as "head" and "nose" within the baby's ken, together with little phrases such as "Baby tumble," "Baby want mummy," and so on. Here we have the secret of the success of such methods as the Berlitz, in which no word of English is spoken from the commencement of the course. The teacher simply points to a picture or an object, at the same time pronouncing its name, which the pupil repeats after him so as to acquire a correct accent. As soon as a number of names have been learned the teacher passes to simple phrases and sentences of action, such as "I shut the door," "I lift the book," carrying out the action whilst speaking. It is wonderful how readily pupils acquire fluency by this method.

Operators on board ship can follow out a similar method by purchasing a phrase book and learning the words and sentences contained therein, not forgetting to pronounce aloud from the phonetic rendering provided. The excellent "Self-Taught" series published by Messrs. Marlborough can be strongly recommended, even for difficult Eastern languages such as Arabic, Turkish or Persian. A dictionary of the "both ways" variety (French-English and English-French, for example) is a necessity, and used in conjunction with the phrase book will enable the student to extract quite a lot of sense from a foreign newspaper. Of course books of the grammatical variety are also useful and there is no harm in having two or three different volumes on hand at the same time, provided some definite line of study is followed in one of them and the others used as aids.



PHONOGRAPH AND WAX CYLINDERS ON WHICH ARE RECORDED FOREIGN WORDS AND PHRASES.

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It is most important to read aloud when studying without a teacher. The ear will in this way become accustomed to the sound of the language, and the student will then be able to profit from a day ashore in a foreign port with the strange language spoken all around him. Great courage is required to make one's first attempts at speaking, but the step need not be dreaded, for nobody abroad dreams of laughing at a foreigner endeavouring to master a new language. Englishmen are strangely sensitive to ridicule, and this is largely the reason why so many people never attempt to speak a foreign tongue. A method introduced within recent years and followed out with success by many students is that of utilising a phonograph and wax records. In this system the student listens to words and sentences on the phonograph, repeated again and again until he is perfectly acquainted with their exact sound and meaning. The records, having been made by a native, are of course without fault in pronunciation, and to a considerable extent take the place of a human teacher. When finished with, they are returned by post to the International Correspondence Schools together with cylinders on which the student has recorded his own pronunciation. This enables criticisms to be made and progress noted. An illustration of one of the phonographs and records will be found above.

Disc records ("His Master's Voice") for use on gramophones and containing French conversation are also obtainable. These are most useful for imparting a correct accent.

Whatever system is adopted, no success will be obtained without patience and perseverance and a great deal of "dry" uninteresting hard work. A keen operator with his head screwed on the right way will find many opportunities in the course of his travels, and after a year or two should have learnt sufficient to speak quite fluently in at least one foreign tongue.

Lastly, when a good grasp has been gained and simple conversations no longer present difficulty, a study of grammar will be found really useful and necessary. But it always should be borne in mind that the goal to aim at is to be able to *think* in the language; when you are able to do this, progress will thenceforth be made quickly and without effort.

Monsieur Emil Frey.

DURING the present European war Mr. Emil Frey, the Director of the International Cable and Telegraph Union, has been working like a Trojan. The Bureau is situated at Berne in Switzerland, of which country Mr. Frey is a former President. The work of Mr. Frey and his *personnel* consists of cable and telegraph tariffs, the adjustment of disputes between countries over rates and procedure, preparation of cable, telegraph and wireless maps and printed volumes, embracing every part of the world that can be reached by any of the modern methods of quick transmission. At the present moment it is Wireless Telegraphy which is making the most rapid strides, and Mr. Frey finds it difficult to keep up with the progress of this new medium of communication.

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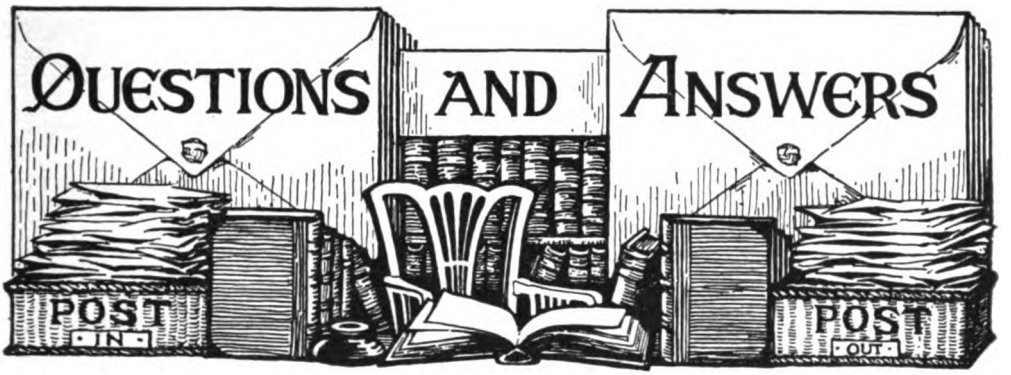

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

A. McK. (B.E.F., France).—Thanks for your letter. It is very difficult for us to advise you in the circumstances, but we would suggest that you renew your application, setting forth your qualifications and mentioning what happened before.

O. C. (Crewe).—Write to the East London Telegraph Training College advertising in this magazine. They will probably be able to give you particulars.

T. T. (Charlbury).—The demand for operators on English land stations is strictly limited, and such positions can only be held by trained and experienced men. There is a far greater demand for wireless operators for service in the mercantile marine, and to obtain such a position you would have to undergo a course of training. Your writing and spelling need attention if you wish to take up wireless telegraphy.

P. R. (Barrow).—The formula for the capacity of a plate condenser is:

$$C_{mfds} = \frac{AK}{4\pi d \times 900{,}000}$$

where

K = specific inductive capacity of dielectric
d = thickness in centimetres
A = area of one of the metal plates in contact with the dielectric.

The capacity worked out in the instructional article on p. 666 of Vol. II. WIRELESS WORLD is correctly calculated by this formula. The formula on p. 601 is quite correct, but is perhaps less clearly put. Referring to Fig. 2 on the same page, there are six sheets of dielectric but only three metal plates on one side and four on the other in the condenser shown.

Hence to obtain the capacity either use the formula for a single sheet condenser of the same dimensions and multiply by the number of sheets of dielectric or else multiply it by *twice* the smaller number of metal plates.

It is evident that

$$2\frac{NAK}{4\pi d} = \frac{NAK}{2\pi d}$$

where N = smaller number of metal plates.

To avoid confusion it is as well to consider the number of sheets of dielectric in the condenser and not the metal plates.

Owing to pressure on our space, the answers to your other questions must be held over.

"Radio" (Harringay).—Yes, we believe there are excellent chances of such promotion for men who take a keen interest in their work. R.N. operators have to pass an examination much more searching than that for the P.M.G. certificate. Regarding the transfer you mention it might be arranged, but we do not think it would be possible until after you have joined up. Then apply to the Commanding Officer.

M. B. (Paris).—Your question is quite clear. The apparatus at Poldhu is duplicated, one set being used one night and the other the next. In this way both sets are kept in good condition. There is a slight difference in power between the two sets.

A. E. W. (Southend).—The Admiralty.

F. G. G. (Ruddington).—Consult the advertisements in THE WIRELESS WORLD for schools of wireless in London. Any of them will send you particulars.

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L. D. (Nice) writes: "Referring to the use "of the earth arrester, I fail to see how a large "amount of current does not pass through the "multiple tuner while transmitting, for the "multiple tuner is generally tuned to receive "a 600-metre wave while the wave transmitted "is also 600 metre."

Answer.—A considerable current does pass through the tuner, and in fact often sparks across the micrometer gap of the instrument. Nevertheless it should be remembered that the path across the arrester gap and down the earth lead is, once the spark had occurred, of a very much lower resistance. The tuner, therefore, is shunted by a low resistance path which takes most of the transmitting current. There is no such shunt during reception and the whole of the aerial current then passes to the receiver.

E. J. (Cardiff).—Study the *Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, obtainable from The Wireless Press, Ltd. (1s. 2d., post free). You should also study the construction and design of portable wireless apparatus. This, with the knowledge of surveying you possess, should greatly assist you in obtaining a position in the Royal Engineers.

A. McC. (Glasgow).—The wireless apparatus on board ship is under the care of the operator-in-charge, who is responsible to the commander. The operators hold the position of honorary officers. An operator at sea can rise to the position of travelling inspector, the salary depending upon his length of service. On shore he may become a resident inspector or take up a special position which happens to be vacant. Naturally vacancies for the highest positions but seldom arise. It is impossible to answer your question as to whether the "wireless profession is as good as the engineering profession." Wireless telegraphy is largely a branch of electrical engineering, and cannot be separated from it. Therefore one cannot speak of "wireless" as one profession and "engineering" as another. Your fifth question had better be put to the Admiralty. In reply to the sixth, good eyesight and general health are required for wireless operating, but the fact that the applicant wears glasses does not debar him from acceptance in the Marconi service.

Robt. E. B. (Hexham).—We have communicated with some people who will write you in due course, and we hope good may come of it. Let us know what happens. Thanks for kind appreciation of our magazine.

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F. X. S. (Shanghai).—Thanks for your suggestions, which will receive consideration in preparing the second series of records. The following is the form of preamble of a telegram from coast to ship:—

Commencing sign—Prefix (if any)—Radio—Name of office of origin—Number of telegram—Number of words—Date and time of handing in—Service instructions (if any)—Break sign—Supplementary instructions (if any)—Break sign—Address, etc. Thus:—

— . — . — Radio Calcutta, 4, 6, 12, 9.35 m.
— . . . — Jones *Olympic* Landsend, etc.

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The Jutland Battle

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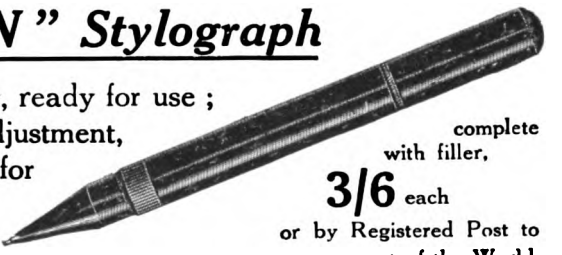

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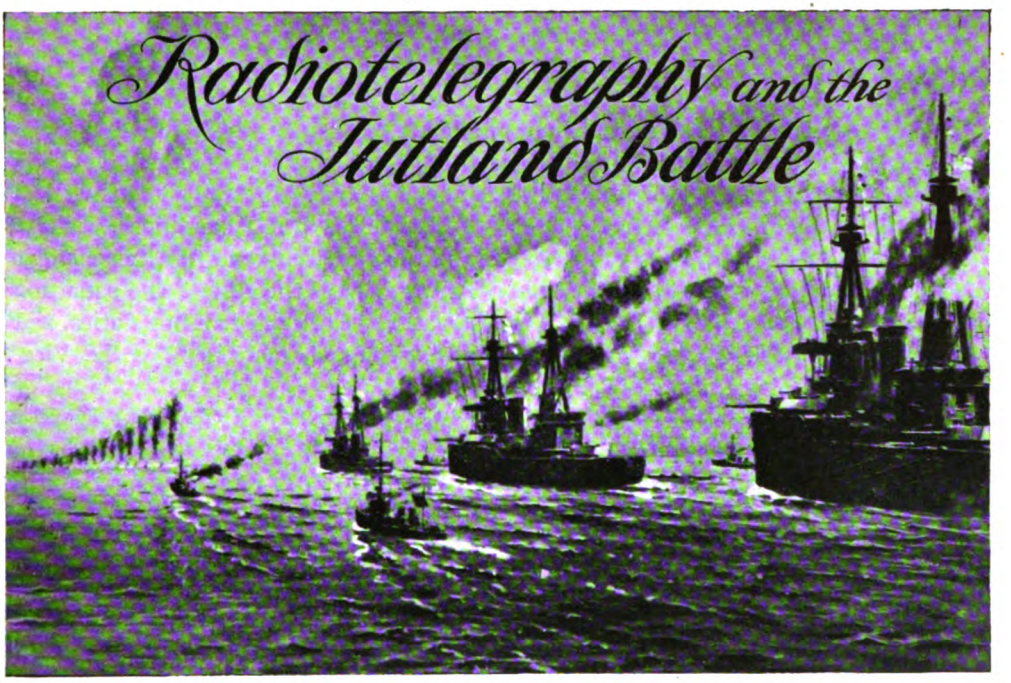
Radiotelegraphy and the Jutland Battle



DURING what we may term the "Period of Apology," when everyone was trying to account for the ineptitude of British official news-issue, some of the daily Press represented Sir John Jellicoe as reluctant to use wireless. As we have often pointed out, Sir John Jellicoe is probably one of the greatest users of wireless in the world, and towards the close of his despatch, recently published verbatim, he passes the following high encomium on the working of radiotelegraphy and those engaged in its operation. The British Admiral's words are worth reproducing textually :—

"The high state of efficiency of the wireless telegraphic arrangements of the "Fleet, and the facility with which they were worked before, during and after the "action, is a great testimony to the indefatigable work carried out by Comm. Richard "L. Nicholson. His services have been invaluable throughout the war. A special "word of praise is due to the Wireless Departments in all the ships."

Comment is needless ; our great sailor has sufficiently answered the criticism above referred to.

When Sir David Beatty was cruising on the afternoon of May 31st, 1916, the news of the enemy's approach was first intimated to him from the *Galatea*. In consequence the Admiral ordered Lieut.-Comm. C. G. Robinson, who was in charge of the *Engadine* (the seaplane parent-ship), to send up one of his machines for scouting purposes. Important results were obtained by the observations so made, which, owing to clouds, had to be carried out at an elevation of but 900 feet. The German light cruiser screen was discovered ; the British line of battle was formed, the course altered, and the action started at 3.48 p.m., beginning at a range of 18,500 yards. Now the first reports from the *Galatea* were probably, and those

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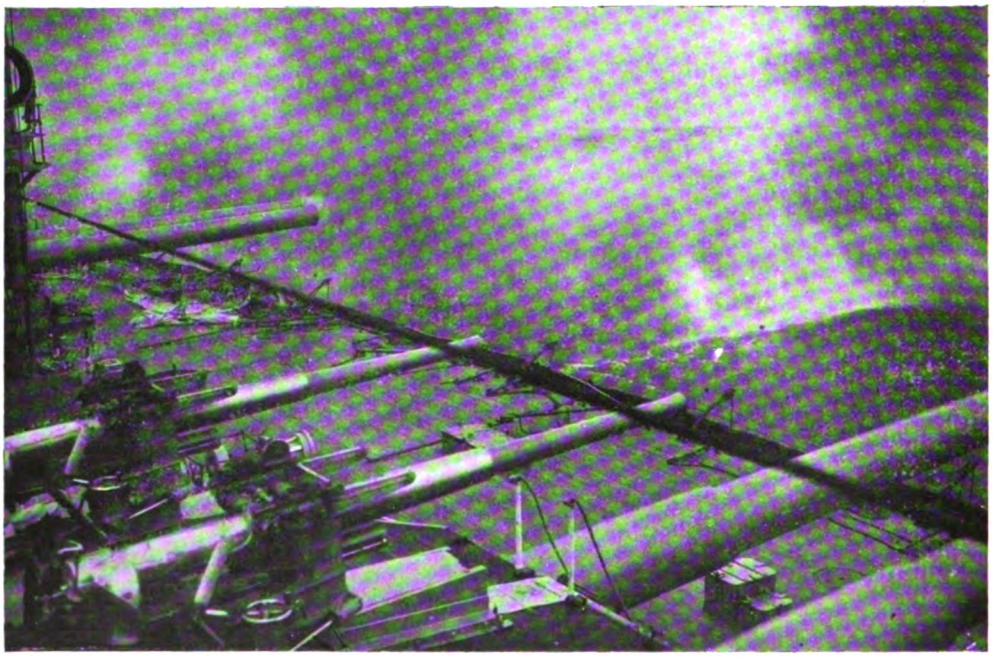
from the seaplane were undoubtedly, conveyed by wireless. Moreover, an independent account, furnished by one of the signallers who took part, sent to his mother and published in the Press, speaks of their "wireless reports on the sighting of "the enemy on May the 31st." Indeed, the visibility difficulties which were noted at the start of Sir David Beatty's despatch, and which lasted practically all through the engagement, lead us to the conclusion that visual means of signalling were less utilised than usual, so that more absolute reliance had to be reposed in wireless telegraphy, which alone is independent of all such weather conditions. About two hours after the engagement started, the *Southampton* reported the enemy's battle fleet ahead, and was despatched southward, with the rest of the squadron to which she belonged, in order to make observations, carry out scouting duties, and report results. The reports from the *Southampton* are characterised by the Vice-



Admiral as "most valuable"; again the general course of the Fleet was altered, and the Fifth Battle Squadron was advised of the enemy's position. Here we have outlined, in plain official language, a graphic kinema picture. Our mental vision discerns the approach of the British light cruiser squadron to the German leviathans of war, the hail of shot with which they were greeted by the enemy, and the skilful handling of the vessels. This swift manœuvring achieved a double object: (*a*) it enabled our gallant British sea scouts to escape practically unscathed from the German fire, and (*b*) it afforded our men ample opportunity for making the observations they were sent out to perform. And all this was going on to the accompaniment of bursting shells and guns booming; whilst, as the vessels glided swiftly to and fro, wireless messages were being radiated from the aerials of the British vessels for the information and guidance of their chief.

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TELEGRAPHIST
CLIFFORD HIRST.

By 5.35 p.m. the battle between Beatty's gallant squadron and the main force of the enemy was in full progress, and the gallant commander communicated the state of affairs to Admiral Jellicoe, still completely out of sight. To quote Sir David's own words: "I made a report to you that the "enemy battle cruisers were bearing south-east." Here again the bad visibility was once more insisted upon. "At this time only three of the enemy "battle cruisers were visible"; and an hour later "the visibility at this time was very indifferent, "not more than four miles, and the enemy's ships "were temporarily lost sight of." The value of wireless telegraphy under such circumstances can hardly be too strongly insisted upon. Just after 7 p.m. the still invisible Jellicoe transmitted a signal to Sir David Beatty informing him that the British main fleet was steering south, and subsequent signals relative to Sir John's position continued to reach the aerials of Sir David's flagship up to 8.46 p.m.

The concluding paragraph of the Vice-Admiral's report contains a series of testimonials to some of the gallant officers of his own vessel, and makes special mention of his Flag-Lieutenant, "Comm. R. F. "Seymour, who maintained efficient communication "under the most difficult circumstances, despite the "fact that his signalling appliances were continually "shot away." It requires no very highly imaginative faculty to draw a mental picture of such conditions, the hail of shot and shell coming so thick and fast as to sever the wireless aerials, the coolness under most trying circumstances of the officers in charge, and the gallant bearing of the men to whom was assigned the task of repairing the apparatus in the midst of such heavy fire.

FIRST-CLASS TELEGRAPHIST
W. H. SMITH.

Sir John Jellicoe's own despatch shows that about a quarter-past six in the evening the British Battle Fleet was meeting and falling in line with their Dreadnought cruisers and the Fifth Battle Squadron. This was an operation requiring the greatest delicacy, and, in the Commander's own words, "great care was necessary to "ensure that our own ships were not mistaken for "enemy vessels." These complicated evolutions were carried out with complete success, and in the course thereof the Wireless Rooms must have been kept busy indeed.

TELEGRAPHIST
KENNETH A. J. MOORE.

All sorts of theories have been put forward to account for what some people were pleased to look upon as delay on the part of the British Admiral in

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TELEGRAPHIST
H. B. TOWNSHEND.

transmitting details of the engagement. But it must be remembered that in the course of the pursuit of the beaten foe, whose return to port appears to have partaken of the character of *sauve qui peut*, a number of British units got separated from the main body, and their Wireless reports as to their whereabouts and course of action could not be considered final, until they had been obliged to relinquish all hopes of further contact with the enemy. A significant passage in the course of the despatch states that: "It is not known when the *Black Prince* was sunk, but a Wireless Signal was "received from her between 8 and 9 p.m." It would obviously have been impossible for Sir John Jellicoe to draw a final conclusion, and report the total loss of this vessel without waiting for a proper interval between the receipt of her last Wireless message and the hour at which, judging from that message, she should have reported herself after the engagement was over.

We have no record of the employment of any airship by the British, but Sir David Beatty makes mention of German Zeppelins, whilst Sir John Jellicoe states that "at 4 a.m. (on the following morning) the Fleet engaged a Zeppelin for about "five minutes, during which time she had ample opportunity to note and subse-"quently report the position and course of the British Fleet." It is highly probable that it was largely due to the watchfulness of the enemy, which this means afforded him, and to the Wireless messages they transmitted to the German Admiral, that the British sailors were robbed of the chance of reaping the full fruits of their victory. If this were so, the German Wireless men must have indeed earned the meed of praise which in his own flamboyant style the Kaiser bestowed upon them on his visit to his battered "remnants" at Kiel. Incidentally, we may observe that the presence of this enemy Zeppelin hovering over the British Fleet, and wirelessing its position, shows that the German lying vaunts about their "naval victory" and "occupation of the scene of action" were of the *frigid and calculating* order. They were plainly "sinning against the light."

Various independent reports have been written by Wireless men who took part in the action, and extracts from some of them have been published in the Daily Press. These go to confirm the points made in our commentary on the official despatches, and need not be specially mentioned, except to remark that they all breathe a spirit of cheerful confidence and devotion to duty, besides emphasising, in a manner impossible for official despatches, the magnitude of the German losses, which circumstances have not up to the present afforded a chance of proving by irrefutable evidence, but which will doubtless be so established later on.

TELEGRAPHIST
SYDNEY MULLINS.

It is the fashion nowadays to denominate lists of those who have laid down their lives in the cause of Patriotism and Humanity as a "Roll of Honour,"

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FIRST-CLASS TELEGRAPHIST
ERNEST GEORGE NEWILL.

This is no unhappy thought, and, as far as the men themselves are concerned, we need none of us desire a better epitaph. We will not quote the too well-known lines of Lord Macaulay; but it is impossible not to recognise the truth of his idea that we must all pay the debt of nature some time or other, and no one can find a better occasion whereon to pay it than on the stricken field when men fight for their Motherland and those who are dear to them. But the point of view of those left behind differs materially from theirs, and, when we come to make up a list such as those of the Wireless Operators who "died that England might live," our heart goes out to the relatives in their distress. The latter can best seek their consolation in the thought that their sorrow, deep and fitting though it be, only affects their own feelings and their own individuality; those whom they love are beyond the reach of sorrow.

One of the first points to arrest our attention is the extreme youthfulness of these operators. Mr. Ernest Kemp, Warrant Officer of Wireless Telegraphy, appears to have been the eldest radiotelegraphist who lost his life on that occasion. He was in his 37th year, and leaves a widow and a two-year-old son at Portsmouth to mourn his loss. He was a London boy and received his education at schools in Dulwich; whilst his period of service in the Navy extended to twenty years. He died on H.M.S. *Invincible*, and two young colleagues on the same vessel perished with him. These were Walter Leslie Monk and Clifford Hirst. Mr. Monk was the son of an old Navy man, and—we regret to say—the only son. He was brought up by his parents at Chippenham, and educated at St. Paul's School in that town. He was but eighteen years of age, and his home was at King's Langley, in Hertfordshire. The other Telegraphist who perished on the same ship, Mr. Clifford Hirst, was a Yorkshire boy, son of Mr. J. Hirst, of Liversedge. He was educated at the secondary school in the High Street of the neighbouring town of Heckmondwike. He joined the Navy only just before the war, at the age of seventeen, and recently passed brilliantly an examination in Wireless Telegraphy. At the end of April he was home for ten days' leave, and only returned to his sea duties a month before the battle. Mr. W. H. Smith, First-Class Telegraphist on the same vessel, was severely wounded, but escaped with his life. When the war started he was in the employment of a Northampton firm, joined the Navy a year ago, specialised in Wireless Telegraphy, and qualified as a first-class operator. He had taken part in the Suvla Bay landing operations at Gallipoli, and in the final evacuation. He was at that time carried on the books of H.M.S. *Glory*. His brother is a Petty Officer on one of the destroyers attached to the High Fleet.

TELEGRAPHIST
BERNARD G. INESON.

The *Tipperary* was one of the magnificent British destroyers which did such glorious work and paid the price of victory. The parents of Mr. Harold Wilsher were consequently notified that their son was on board

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LEADING TELEGRAPHIST
ARTHUR ELWIS.

and must be regarded as having lost his life. In their case, however, subsequent information corrected the earlier evil tidings. We understand that a letter has been received from the young man stating that he was picked up without a scratch, though his vessel was in flames when he left her, and he is now a prisoner in Germany. Although but nineteen this wireless telegraphist has been in the Navy nearly five years, and before joining the *Tipperary* twelve months ago (apparently when she was first commissioned) had served on the *Achilles*. He is a Londoner, educated at Oaklands Road, Hanwell, and his parents are now living in that district. He also has two brothers in the Navy. His senior officer, Mr. Edwin Dymott, Warrant Officer of Wireless Telegraphy on the same vessel, was not equally fortunate and went down with the ship. On the sister destroyer H.M.S. *Turbulent*, which shared in the gallant deeds and fate of the *Tipperary*, there perished Mr. Kenneth A. J. Moore, son of Mr. Herbert Moore, of Foxcote, near Radstock. This was a young man who, although but in his sixteenth year, had given unusual promise during the twelve months which constituted his period of service in the British Navy. An intense lover of animals, he never failed in his letters home to enquire after his pets.

Probably the most serious loss of the British, from the point of view of *matériel*, was that of the superb battle cruiser *Queen Mary*. Mr. H. B. Townshend, wireless operator on board, passed his first examination for wireless when he was only sixteen years of age, and we learn that one of his officers informed him at the time that he was the youngest operator in the Fleet, an honour of which he was justly proud. Recent letters home announced that he had just gone through a further examination, the result of which was to be published at the beginning of June. By that time Mr. Townshend had passed beyond the reach of examiners and laid down his young life upon the altar of his Motherland. A colleague of his who also perished was Mr. Sydney Mullins, a native of Marfleet, seventeen years of age, and formerly a telegraph messenger-boy at Hull Post Office.

A Manchester lad, Mr. Walter Fletcher Gardner was serving on H.M.S. *Hampshire* when he was struck down. His age was seventeen, and his rank that of boy telegraphist. He entered the Navy in May, 1914, and received his training in radiotelegraphy on H.M.S. *Powerful*, having been transferred to the *Hampshire* about twelve months ago. He belonged to an old-established Manchester family, and was the great-grandson of Alderman James Fletcher, a well-known engineer of Salford.

Mr. Ernest Newill died on board the *Indefatigable*. His parents belong to Goodmayes in Essex, and the young man in November, 1914, at sixteen years of age,

LEADING TELEGRAPHIST
CHARLES T. W. HURD.

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left his employment in the City, joined the Navy, was sent to Devonport, and started training as a wireless telegraphist. His probationary period was shortened on the outbreak of war, and he was ultimately transferred to the *Indefatigable.* He was educated at Goodmayes School, Ilford, and was very popular both at school and amongst his neighbours. At the time of his death he was between seventeen and eighteen years of age and of fine physique. His brother is serving in the Army.

Another only son was Telegraphist Bernard Grimshaw Ineson, who was killed on H.M.S. *Barham.* The son of a lady in Crewe, he was seventeen years of age, when he was killed by a shell at his post with the instruments attached to his head. He was a clever operator, and his Captain in a letter addressed to his mother stated " he should have had a brilliant career, and was marked out for early advancement." A chum on board also wrote to his mother and dwelt upon the lad's popularity with his messmates.

Mr. Arthur Elwis was Leading Telegraphist on H.M.S. *Defence,* and the son of a signalman on the Great Central Railway. He had been for four years and ten months in the Navy, and had only recently received his appointment to the responsible post which he was holding at the time of his death. He joined the Navy at about sixteen, and came of age in last December. He was educated at Doncaster British School, and after leaving he entered the service of the Great Central Railway as a clerk. He won a school certificate for swimming, and had been choir boy both at St. Jude's and St. Mary's, Wheatley. His brother and his brother-in-law are both in the Army.

Besides those actually engaged in wireless duties at the time of their deaths there are other gallant gentlemen the loss of whom we have to mourn whose interest in and services to Wireless Telegraphy have been notable. Amongst these we must number Commander A. E. Silvertop, of H.M.S. *Defence.* He was one of the earliest experimenters with Wireless Telegraphy in the British Navy and was lent to the Somaliland Expedition of 1903 to take charge of two sets of Marconi apparatus.

On H.M. destroyer *Ardent* perished Leading Telegraphist Charles T. W. Hurd, of Tunbridge Wells. His parents received the intimation of his loss from the Admiralty, their statement being based on the fact that he was not amongst the survivors from that vessel. He was in his twenty-second year, and received his training at St. James's School. The Lieutenant-Commander in charge of his vessel writes that, during a momentary lull in the avalanche of German concentrated fire, Hurd received orders to send his final wireless message, went off to execute his duty and was never seen again.

Warrant Telegraphist Henry Arberry died on H.M.S. *Defence* ; whilst included in the " Roll of Honour," though not assigned to any ship, is Acting-Warrant-Telegraphist Henry Burnell. We cannot conclude our list without making mention of Mr. Chas. Clifford Massey, of H.M.S. *Black Prince,* who, after serving his apprenticeship at Crewe Railway Works, joined the staff of the Marconi Works at Chelmsford, and entered the Navy three years ago.

Verily the " Roll of Honour " of wireless telegraphists grows apace. These young men have never failed to display in a remarkable degree that cool courage which we are all rejoiced to realise is still characteristic of our race.

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PERSONALITIES IN THE WIRELESS WORLD

Professor ALFRED N. GOLDSMITH,
D.Sc., Ph.D.

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PROMINENT among the younger American scientists who have contributed so much to the progress of radiotelegraphy, Professor Alfred N. Goldsmith, D.Sc., Ph.D., is well known on this side of the Atlantic, through many papers on his favourite subjects.

Professor Goldsmith was born in New York, and also received his education there, graduating from the College of the City of New York and Columbia University. It is interesting to know that of the former place he is now Director of Radio Engineering, and America owes much to the researches which he has carried out in the well-equipped laboratories of that institution.

He is perhaps best known in England as editor of the *Proceedings of the Institute of Radio Engineers*, that admirably compiled publication which is the means of distributing so much useful information to students and research workers alike. In addition to acting as editor of these Proceedings, Professor Goldsmith holds the position of chairman of the Standardisation Committee of this institution, and also has a place on the Board of Direction.

Other societies in which the subject of our biography takes an active part are the American Institute of Electrical Engineers and the American Physical Society, of both of which he is a member. He is the author of *Elements on Physics, The Transmission of Canal Rays Through Thin Partitions, Radio Engineering at the College and City of New York, Engineering Measurements of Radiotelegraphy, Radio Telephony*, and other works.

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The Design of the Audio Frequency Circuit of Quenched Spark Transmitters

By JULIUS WEINBERGER

(Including a Supplementary Discussion of " Resonance Phenomena in the Low-Frequency Circuit," by H. E. Hallborg.—WIRELESS WORLD, APRIL-MAY, 1915.)

(*Reproduced, by permission, from the " Proceedings of the Institute of Radio Engineers."*)

A LARGE number of contributions to the literature of radio-telegraphy have been made upon the subject of the so-called " resonance transformer." These have been both experimental and theoretical. The experimental contributions, as a general rule, have been investigations of the resonance transformer under actual operating conditions (that is, with the secondary condenser discharging periodically through a spark gap), while the theoretical contributions have generally assumed a steady state of affairs (the secondary condenser *not* being discharged); in this case the method of treatment has been that employed for two coupled circuits.

In actual practice, such as in the operation of quenched gap sets, the requirement of a clear note involves the discharge of the secondary condenser at the peak of the wave each half cycle. It would seem, therefore, that the transient phenomena in the circuit would be the determining factors of voltage and current, rather than those of the steady state of affairs; that is, conditions would never assume the steady state.

To investigate these conditions, we can reduce the whole resonance transformer circuit to that of a simple inductance, capacity and resistance in series (Fig. 1), as has been shown by Mr. Hallborg. The inductance, L, includes all the inductances in the circuit—generator inductance, transformer leakage inductance, inductance of any series choke coils, and so on. The condenser, C, is the secondary condenser reduced to the primary circuit by multiplication by the square of the ratio of transformer voltages. The resistance, R, includes resistances in the primary circuit and resistances in the secondary circuit reduced to the primary by division by the square of the ratio of transformer voltages.

The differential equation for such a circuit is :

$$e = E \cos(\theta - \theta_o) = Ri + x\frac{di}{d\theta} + x_c \int i\, d\theta$$

where :

E = maximum generated * voltage.

x_c = condenser reactance.

x = inductive reactance.

$\theta = \omega t$.

θ_o = an angle to be subtracted from θ if e is not zero for $t = 0$.

* This is *not* the voltage across the generator terminals. If the generator armature has appreciable inductance (in comparison with the rest of the circuit) there will be a drop in voltage inside of the armature and a very much higher voltage will actually be *generated* than that which is measured at the terminals.

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The potential difference across the condenser terminals can be found from :

$$V = x_c \int i \, d\theta$$

when equation (1) has been solved for i.

Since we are mainly concerned with this, V, we will omit writing the solution for i, but give that for V immediately :

$$V = \frac{Ex_c}{Z} \sin(\theta - \theta_0 - \gamma) + \frac{Ex_c}{Z} \epsilon^{-\frac{R\theta}{2x}} \left\{ \sin(\theta_0 + \gamma) \cos \frac{q}{2x}\theta + \left[\frac{R}{q} \sin(\theta_0 + \gamma) - \frac{2x}{q} \cos(\theta_0 + \gamma) \right] \sin \frac{q}{2x}\theta \right\}$$
$$+ \epsilon^{-\frac{R\theta}{2x}} \left\{ e_0 \cos \frac{q}{2x}\theta + \frac{2Re_0 + 4xx_c i_0}{2q} \sin \frac{q}{2x}\theta \right\}$$

where

Z = impedance.

γ = phase difference.

$q = \sqrt{4xx_c - R^2}$.

e_0 = value of potential difference across condenser terminals at the time $t = 0$.

i_0 = value of current through the circuit at the time $t = 0$.

Consider the conditions introduced in the circuit immediately after the condenser has sparked over, at one peak of a cycle, and the spark has ceased. This is the moment for which we take $t = 0$. The important thing to be determined is :—What will be the voltage across the condenser for $\theta = \pi$ (that is, at the next peak of the cycle) ? Will it rise to a sufficient value to cause another discharge ? Or, rather, will it rise to a value equal to that, at least, at which the previous discharge took place ? If not, the requirements of a clear note, of twice the generator frequency, will not be fulfilled. Also, it is this discharge voltage which determines the energy absorbed by the condenser.

Taking the equation given for V, we can introduce the following simplifications :

(1) Since we will consider the circuit as being resonant, we have $x_c = x$, and shall substitute x for x_c accordingly, throughout.

(2) Since the circuit is resonant, the current and generated voltage are in phase, hence $\gamma = 0$.

(3) When the condenser discharges, the potential difference between its plates is reduced to zero. Hence, at the moment we are considering, $e_0 = 0$.

(4) The spark occurs when the generated voltage is zero. Since i_0 is in phase with e_0, $i_0 = 0$.

(5) Since the circuit is resonance, $Z = R$.

(6) R^2 can usually be neglected as compared with $4xx_c$.

Hence $q = 2\sqrt{xx_c}$.

Or, since $x = x_c$

$q = 2x$

(7) In our case $\theta_0 = \frac{\pi}{2}$.

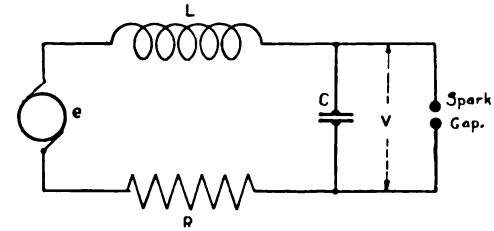

FIG. 1.

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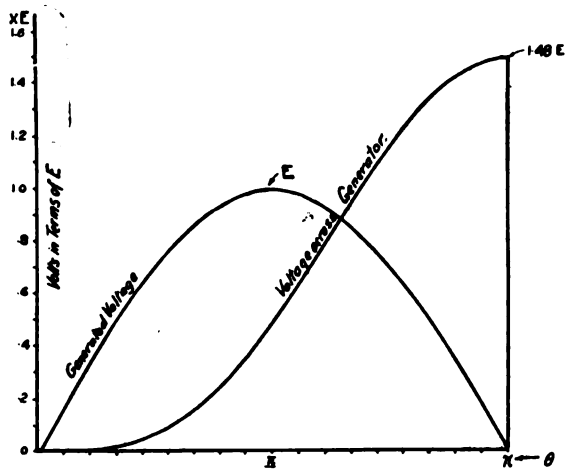

FIG. 2.

Substituting these conditions, we obtain :

$$V=\frac{Ex}{R}\sin\left(\theta-\frac{\pi}{2}\right)+\frac{Ex}{R}\epsilon^{-\frac{R\theta}{2x}}\left\{\cos\theta+\frac{R}{2x}\sin\theta\right\}$$

$$=\frac{Ex}{R}(-\cos\theta)+\frac{Ex}{R}\epsilon^{-\frac{R\theta}{2x}}\left\{\cos\theta+\frac{R}{2x}\sin\theta\right\}$$

To show the general shape of this curve, which gives the voltage across the condenser at any moment after the time $t=0$, it has been calculated for a specific case ($C=20$ microfarads and $R=1$ ohm), and is shown in Fig. 2. In the same figure the curve of generated voltage (a sine wave) is given for comparison.

This condenser voltage, V, will reach its maximum for $\theta=\pi$. It will then be :

$$V_{max.}=\frac{Ex}{R}-\frac{Ex}{R}\epsilon^{-\frac{\pi R}{2x}}$$

$$=\frac{Ex}{R}\left(1-\epsilon^{-\frac{\pi R}{2x}}\right)$$

This, then, is the potential at which our " reduced " condenser will discharge. The actual condenser, across the transformer secondary, will, of course, discharge at a voltage which is simply this $V_{max.}$ multiplied by the transformer ratio. In Fig. 3 curves are given for $V_{max.}$ in terms of E (the maximum generated voltage). It will be seen that for ordinary conditions of resistance (that is, R between zero and 1 ohm) $V=1.5\,E$ is a good average value.

To find the R.M.S., or effective value of V, is desirable, since this is the voltage that a voltmeter placed across the transformer primary will read, and this is also the voltage for which the transformer primary must be designed when the equation

$$V_{eff.}=4.44\,AB_{nf}.10^{-8}$$

is used, where

$V_{eff.}$ = R.M.S. volts across transformer primary.
A = cross sectional area of core in square cms.
B = flux density, in lines per square cm.
N = number of turns of primary winding.
f = supply frequency.

This effective value of V is :

$$V_{eff.}=\sqrt{\frac{1}{\pi}\int_0^{\pi}\left(-\frac{Ex}{R}\cos\theta+\frac{Ex}{R}\epsilon^{-\frac{R\theta}{2x}}\left\{\cos\theta+\frac{R}{2x}\sin\theta\right\}\right)^2}$$

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It is found* that :

$$V_{eff.} = 0.504\ V_{max.}$$

The design of a quenched gap set to operate under resonance conditions becomes a relatively simple matter. Let us take a numerical example for a 500-cycle, 1 kilowatt set, operating with a 110-volt generator (154 volts maximum).

We shall first find the equivalent primary condenser (i.e. the secondary condenser reduced to the primary circuit), required to absorb 1,000 watts, from :

$$W = nCV^2.$$

Since $V = 1.5E = (1.5)\ (110)\ \sqrt{2} = 233$ volts.

Hence $1000 = 500C\ (233)^2.$

$C = 37$ microfarads.

To tune to 500 cycles with this capacity, an inductance of 2·5 millihenrys is required. This can be made up partly from the generator armature inductance (usually this is between 1 and 5 millihenrys for a 1 kilowatt, 110-volt machine), and the rest obtained either by a transformer having this amount of leakage inductance, or else from a transformer with no appreciable leakage and series choke coils. I believe the latter method to be preferable as it admits of greater flexibility.

The value of the equivalent primary condenser (or, rather, the "reduced" secondary condenser, as I have called it) being now fixed, the actual secondary condenser is determined by deciding on a suitable transformer ratio. The value of this secondary condenser is usually limited by conditions of wave length and also by the discharge current which the quenched gap in use will stand. A large condenser means heavy currents and considerable heating in the gap, while a high discharge voltage and a small condenser would require many gap sections and cause insulation difficulties. It is, I believe, common practice to employ about 0·006 microfarads as a secondary condenser for this type of set.

Having thus determined the ratio of primary to secondary capacities, the transformer ratio is, of course, fixed ; and it is only necessary to design a transformer of the ratio desired—a simple matter with a closed core transformer of negligible leakage. Note should be taken of the fact previously mentioned that when the usual transformer formulas are used, the effective value of V (that is 0·504 $V_{max.}$) should be used as the voltage across the primary.

Practically, the operation of quenched gap sets is at a point slightly "off" resonance. However, it is hardly necessary

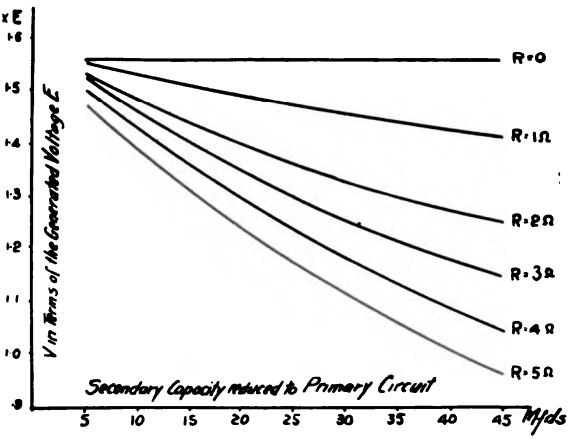

FIG. 3.

* This value was determined graphically, the integration being done by measuring the area of the squared curve with a planimeter.

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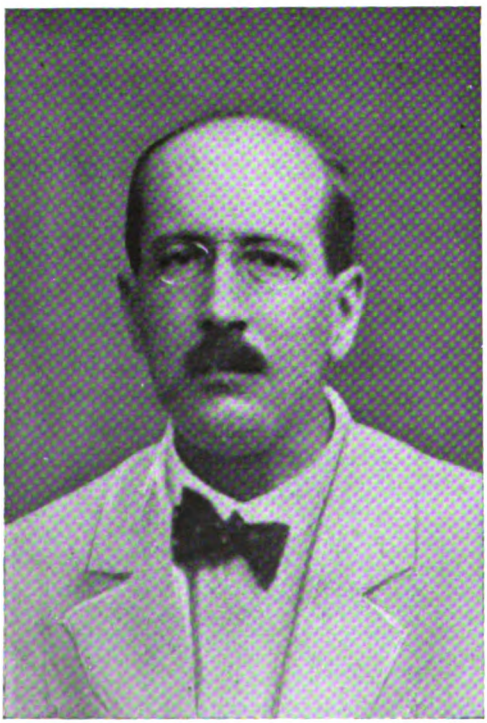
to operate with a condenser as much as 20 per cent. larger than the resonance capacity. The foregoing results can, therefore, be applied as very good approximations to actual practice, and have been found to be quite satisfactory for this purpose.

[Since the above was written I have become aware of an article by L. B. Turner* upon the same subject. Following a somewhat different procedure, Turner reaches practically the same results as given above, with the exception that he neglects the resistance of the circuit. As Fig. 3 shows, however, this would lead to considerable inaccuracies, for large resistances, and is strictly correct only for $R=0$. Turner obtains the result :

$$V=\frac{\pi}{2}E.]$$

The Late Mr. E. W. Salis

IT is with the deepest regret that we have to announce the death of Mr. E. W. Salis, Brazilian representative of Marconi's Wireless Telegraph Co., Ltd.



The deceased gentleman, who was the third son of the late Major-General Salis Schwabe, C.B., formerly of the Carabiniers and 16th Lancers, was grandson of Lord Justice Sir W. M. James. Born in Ireland in the year 1874, he was educated at Marlborough and at the City of London and Guilds Institute. On the termination of his college career he spent a short time in the business of Messrs. Salis-Schwabe, Ltd., of Manchester, and there became a member of a private Commission sent by the Home Office to Russia. He next started a business in Vladivostock, Siberia, in partnership with his cousin. In 1906 Mr. Salis was appointed manager of the Manaos Harbour Co., and after five years in that position joined the Marconi Company as Brazilian representative. The deceased had been in bad health for some time, and underwent an operation for cancer of the tongue. To this disease his last illness owed its fatal termination.

* L. B. Turner, *Electrician*, Vol. 69, 1912, p. 694 : "Der Schwingungskreis niedriger Frequenz in der Funkentelegraphie," *Jahrb. d. Drahtl. Tel.*, Vol. 9, Heft 2, p. 141.

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Digest of Wireless Literature

The Resistance of Radiotelegraphic Antenna.

Dr. Louis W. Austin, the well-known Director of the United States Naval Radiotelegraphic Laboratory, has recently published in the Scientific Papers of the Bureau of Standards, No. 257, the following valuable note on the above subject.

According to the theory the portion of the resistance of an earthed antenna due to its radiation is *

$$Rr = 160\,\pi^2\,\frac{h^2}{\lambda^2}$$

which is approximately $1600\,\frac{h^2}{\lambda^2}$

where h is the height from the earth in the centre of capacity of the antenna and λ the wave-length, assuming that the earth below the antenna is a good conductor like salt water. As a matter of fact, in most land stations the effective height is less than the actual height, and in many cases not more than one-half of it. In all antennas, however, radiation resistance must, according to the theory, decrease as the wave-length increases and in accordance with the square law.

It was first noted by C. Fischer † that in certain cases the resistance ‡ of antennas increased as the period was increased by introducing inductance. Fischer believed that this indicated an increase of radiation with wave-length.

The whole course of the phenomenon has been studied by the United States Naval Radio Laboratory, and the results published.§

Fig. 1 shows the resistance curve of the antenna used by the Naval Laboratory at the Bureau of Standards and that of the U.S.S. *Maine*. The first is typical of a land station with poor ground conditions, the curve falling rapidly as the true radiation resistance drops with increasing wave-length, and then rising again in a straight line as the wave-length is further increased. The curve for the *Maine* shows the same drop at the shorter wave-lengths followed by a rise which is very slight. Fig. 2 shows the antenna resistance of the high-power station at Arlington, Va., with the towers grounded.

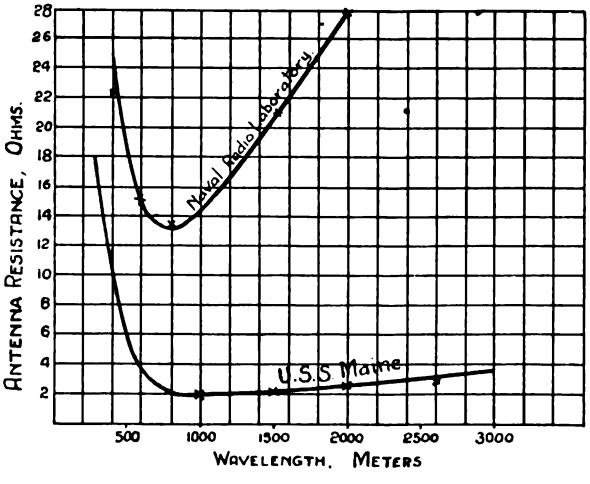

FIG. I.

* *Zenneck Lehrbuch d. drahtlosen Telegraphie*, 1913, p. 202.

† *Phys. Zeit.* 1911, p. 295.

‡ Leaving out of account the resistance of the inductance coils.

§ *Proc. Wash. Acad.* 1, p. 9, 1911; and this *Bulletin* 9, p. 65, 1912; *Scientific Paper* No. 189.

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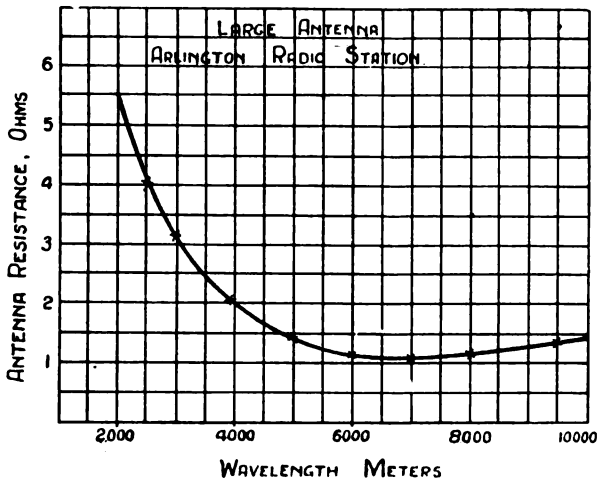

FIG. 2.

Here there is almost no rise as the wave-length is increased, showing how perfect ground conditions can be made by the use of an extensive network of ground wires.

Up to the present there has been no satisfactory explanation of the rise of the antenna resistance curve, although it seems certain that it has something to do with the ground. Experiments by H. True * show, however, that the ground resistance, as indicated by fall of potential methods, is greater at short than at long wave-lengths. If, however, we consider the ground as a dielectric rather than as a conductor, and consider it as a portion of the total dielectric lying between the antenna, regarded as the upper plate of a condenser, and the ground water, regarded as the lower plate, we reach a very probable explanation of the peculiar form of many antenna resistance curves. For it is well known that the equivalent resistance of an imperfect dielectric increases as the wave-length is increased.

As an example † of experiments showing this, the equivalent resistance of a certain glass condenser of approximately 0·002 mf. capacity measured in the Naval Radio Laboratory is shown in Fig. 3. The equivalent resistance of the condenser at the various wave-lengths is determined by placing it in a circuit acted upon by a buzzer-excited wave-meter. The current in the circuit containing the condenser is measured by means of a thermo-element. The condenser under test is then replaced by a variable air condenser adjusted to the

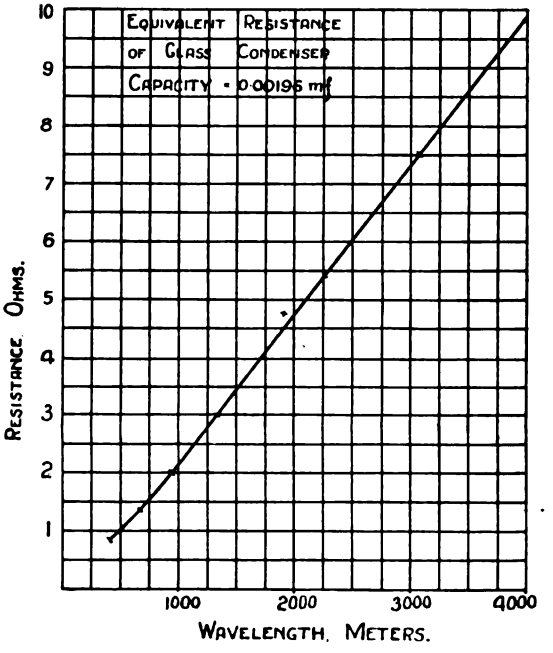

FIG. 3.

* *Jahrbuch d. drahtlosen Telegraphie V.*, p. 125, 1911.

† *Proc. of the Inst. of Radio Engineers*, 1, p. 35, 1913.

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same capacity in series with which resistance is introduced until the thermoelement indicates the same high-frequency current as in the case of the glass condenser. The series resistance then represents the equivalent resistance of the glass condenser. Fig. 3 shows that the equivalent resistance of the glass condenser increases in direct proportion to the wave-length, just as does the resistance of the antenna at the Bureau of Standards beyond 1,500 meters.

The rise in the resistance curve of the *Maine*, as shown in Fig. 1, is probably due to the fact that the measurements were made with the ship in dock, as it is impossible to use sufficiently sensitive galvanometers under other circumstances. With the ship in dock, of course, a considerable portion of the field passes through poor dielectric material before reaching the water.

Lonely Radiotelegraphists

MR. L. B. CLEARY, warrant telegraphist, R.N.R., writes from a naval station in the Seychelles (islands in the Indian Ocean), criticising in somewhat intemperate language a letter which appeared on page 765 of our February issue, from Mr. W. J. Hills, another naval wireless man stationed at Mombasa. The latter had asked any readers who might have a gramophone and records to spare to send them along to his station, " where amusements are practically *nil* and the long evenings very dark " and lonely."

Mr. Cleary informs us that " we at this station here, who hold a similar position " to Mr. Hills, have been able to buy all the necessary things for amusement that we " require, and also subscribe liberally for the comfort of those who are even more " lonely than ourselves."

We congratulate Mr. Cleary on his good fortune, and on his having been able to help in carrying out the good work of which he speaks ; but we are bound to confess that our appreciation of his action would have been more unqualified had his letter displayed a less censorious spirit with regard to his colleague. It is usually extremely unjust to condemn anyone else without a very full acquaintance of all the circumstances surrounding the case in point. The pay of a warrant telegraphist abroad is by no means on a scale liberal enough to justify Mr. Cleary's tirade. We ourselves know personally how extremely expensive existence in such tropical stations as Mombasa frequently is, and we can easily understand the circumstances which would fully justify Mr. Hills' request. We can only hope that the latter has received a machine long before this note appears, and that it has proved as efficient as he hoped in enlivening the monotony and discomfort of his lonely station on the coast of equatorial East Africa.

Wireless Workers at Play

AT the A.A.A. military sports at Stamford Bridge on Saturday, July 8th, the R.F.C. Wireless Section team finished second to the Army Service Corps (M.T.) Grove Park team in the one mile relay race. The winning team was : the Australian sprinter, C. J. Mears, the world's champion, Private W. R. Applegarth, P. Hodge, and S. Wood, while the R.F.C. team was : P. E. Mann, F. Gaby, Saul, and the old Army champion, Sergeant F. Mawby.

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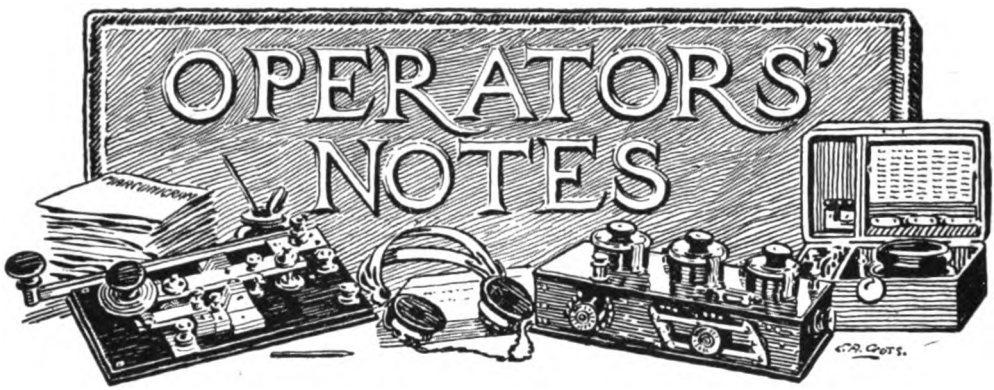

Some Notes on Atmospherics.

The new operator will not be long at sea before he gains considerable practical experience of what are variously known as "atmospherics," "X's," and "static." Although nearly twenty years have passed since wireless came into practical use, and these strange natural signals first recorded themselves on the slow-moving paper tape of the early coherer receivers, the problem of their elimination remains yet to be solved. Numerous means, however, have been incorporated into modern wireless telegraph apparatus, so that nowadays the operator is not so dependent as formerly upon the whims of the clerk of the weather. Sharp tuning, musical notes and balanced receivers enable many trying periods to be overcome, which in the early days would have been "dead" to all wireless communication.

The keen operator, anxious to get the best out of his installation, will observe carefully all that happens during the prevalence of static, and upon the arrival of bad conditions will not give up in despair. It should be remembered that if at one station conditions are so bad that it is impossible to read signals from a station with which one is endeavouring to communicate, it does not follow that the other station is similarly inconvenienced.

The writer of these notes, who at one time had to send a large quantity of important traffic to a station some hundreds of miles away, found that atmospheric trouble was in nearly all cases far worse at his end of the "line." On discovering this he arranged that upon receipt of every message the other station should send for about half a minute a rhythmic series of long dashes. In the event of non-reception a similar series of dots was to be sent. Although conditions were so bad that it was impossible to read any ordinary signals, no difficulty arose in distinguishing these rhythmic signals, and, as a consequence, the traffic, which was practically all one way, was cleared expeditiously.

In tropical and subtropical regions a considerable diminution in strength of static will often be found after sunset, and the quietest periods are frequently between midnight and 3 a.m.

Land station operators working traffic between fixed stations will find it convenient to plot curves of atmospheric and signal strengths, and after a number of these have been prepared, to study them carefully with the view of ascertaining the

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best periods of working in bad seasons. Ship operators will also find it most useful to compile information in this way, with a view to finding the best periods.

Whilst writing on the subject of atmospherics, we think it wise to point out to new operators a source of trouble which is often overlooked. An imperfect aerial connection, caused, for instance, by such a thing as a loose terminal, will often cut off completely the reception of wireless signals, although permitting atmospherics to pass if these latter are strong. The reason for this is that strong atmospherics are frequently sufficiently powerful to spark across the tiny gap, whereas signals from another wireless station are rarely of sufficient strength to do this. It will thus be seen that the fact that atmospherics are heard in the telephone is no indication that the aerial circuit is perfect.

In a given area, when static is giving trouble, it will be found that two ships, quite close to one another, are affected most unequally. The ship with a larger and higher aerial will invariably be the worse sufferer, and the smaller ship will sometimes be able to render valuable assistance to the larger vessel from this cause.

Atmospherics are of various types, some coming through as a low dull rumble, others as violent crashes with comparatively quiet intervals, others again yield whistling and roaring noises. One peculiar type which gives a sound closely resembling escaping steam, will almost invariably be found to herald the approach within five minutes of a squall of sleet. The ability of the wireless operator to announce the coming of such a squall has often caused considerable mystification amongst the navigating officers, who do not know "how it is done."

Speaking generally static is far more prevalent in southern waters than in northern, and in summer more than in winter. Certain equatorial districts are particularly bad, and stations situated amongst the tropical forests of Africa and South America are constantly troubled in this way.

A good, clear, pure, and fairly high musical note has been found the most, successful for transmission through static, and where ample power is employed to "break through" the natural noises, communication is seldom interrupted. In some cases static has been found sufficiently strong to give a continuous roaring spark across a gap as large as one centimetre, and, of course, whilst it is of such violence as this (luckily such periods are infrequent) the operator has no choice but to stop work altogether. Such violent periods, however, are seldom of more than a few minutes' duration.

Plymouth Telegraphist's Retirement

WIRELESS students in the West of England will be interested to hear that Mr. J. Jerritt, who for the last forty-four years has been on the staff of the Post Office, has now been presented by the Plymouth Telegraph Staff and friends with a handsome gold watch on his retirement from the service.

Representing the Wireless Press, Ltd., in the West of England, Mr. Jerritt has long shown a keen interest in the fascinating science, and now intends to turn his wide telegraphic experience to good account by opening a school of telegraphy in Plymouth. In this enterprise we wish him every success.

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Mr. Pidduck's "Treatise on Electricity"*

Reviewed by J. A. FLEMING, M.A., D.Sc., F.R.S.

THE advances in our knowledge of electrical phenomena have been so extensive in the last twenty years or so that it is imperative from time to time to recast the summaries of it to bring them within the compass of books of reasonable size.

Moreover each such book provides, or should provide, for readers of a particular class, elementary, popular, or advanced. Whilst there is no lack of provision for the first two classes the number of books dealing in a fairly advanced manner, but not too mathematically, with the subject are not numerous. The book before us by Mr. Pidduck endeavours to meet the needs of such readers in a text-book of moderate size, covering both the theoretical and practical sides of the subject, and especially some of the most recent advances, we think with success.

The volume opens with a short mathematical introduction explanatory of certain fundamental theorems. It is rather to be regretted that Mr. Pidduck has not embraced the opportunity to illustrate at the outset the physical meaning of these theorems more fully by more explicit electrical illustrations. The physical student approaches the mathematics of the subject from a different point of view to the pure mathematician. The former chiefly desires to have the physical meaning of such theorems expounded. Hence the great advantage of adopting mathematical notations which facilitate it.

Mr. Pidduck adheres to the Cartesian methods. He does not employ the convenient method now so general of representing a vector by a single letter in thick or Clarendon type, and its size or magnitude by a corresponding Roman letter, neither does he devote space to explaining at the start the physical significance of such terms as *divergence, curl, line, surface,* or *volume integrals,* nor avail himself of compact symbolisation for vector and scalar products or operators.

The advanced student who has a small acquaintance with modern vector analysis, such, for instance, as may be obtained from the little book of Dr. J. G. Coffin on Vector Analysis (Chapman and Hall, Ltd., London), will have become familiar with the convenient notation of Willard Gibbs by which the scalar product of two vectors is expressed by a *dot* put between the symbols—*e.g.*, $\mathbf{A}\cdot\mathbf{B}=AB\cos\theta$, where θ is the angle between two vectors of sizes A and B, and the vector product is expressed by a *small cross;* thus $\mathbf{A}\times\mathbf{B}=AB\sin\theta$. Also with the meaning of Hamilton's important delta operator:

$$\nabla=\mathbf{i}\frac{d}{dx}+\mathbf{j}\frac{d}{dy}+\mathbf{k}\frac{d}{dz}$$

where **i**, **j**, and **k** are unit vectors along the axes, the scalar square of which—viz., $\nabla\cdot\nabla$—is Laplace's operator.

If, then, **E** is any vector quantity, say, electric force div **E**, denoted by $\nabla\cdot\mathbf{E}$, is the divergence of **E**, and signifies the number of lines of electric force which proceed

* *A Treatise on Electricity.* By F. B. Pidduck. Cambridge University Press. 14s. net.

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from a unit volume taken in the field, or, perhaps we should say, from an infinitely small volume divided by the volume. The divergence theorem, or, as Mr. Pidduck calls it, Gauss's transformation, becomes then almost a truism because the number of lines of force which proceed outwards normally through any closed space in a field must be equal to the number originating in that volume. In the same notation the curl of a vector quantity $\mathbf{E}$ is denoted by Curl $\mathbf{E}$ or by $\nabla \times \mathbf{E}$, and it is seen at once that Stokes's theorem provides us with a criterion by which we can judge when two vectors are related to each other as primary and curl.

Thus, for instance, if the primary vector is electric force, then its curl is the time rate of change of magnetic flux through unit area, because it fulfils Stokes's condition. For the same reason it would have been an advantage if Mr. Pidduck had explained a little more fully why the differential equation,

$$\frac{d^2\theta}{dx^2} + \frac{d^2\theta}{dy^2} + \frac{d^2\theta}{dz^2} = \frac{1}{c^2}\frac{d^2\theta}{dt^2}$$

or as it may be more compactly written—$\nabla^2\theta = \frac{1}{c^2}\ddot{\theta}$ represents a wave motion; because the notions underlying it are fundamental in connection with Maxwell's theory of the propagation of electromagnetic effects through space.

Following on this short mathematical introduction, the subject of permanent magnetism is treated in Chapter I., the magnetic effect of electric currents in Chapter V., and that of induced magnetism in Chapter VII.

The consideration of the magnetic circuit from the standpoint of modern electrical engineering does not appear to be quite adequately considered, but the first chapter is occupied with the effects of permanently magnetised iron or steel and with the conceptions of lines and tubes of magnetic force, and with the absolute measurement of terrestrial magnetic force. The discussion of electromagnets and of the phenomena of magnetic hysteresis is deferred until Chapter VII. is reached.

As the title of the book is "A Treatise on Electricity," and not "Electricity and Magnetism," the discussion of magnetic phenomena is carried only so far as is necessary for the main purpose of the book.

This opens with an examination of electrostatic effects in Chapter III. We are glad to notice that here modern views of the atomic constitution of electricity—viz., the electron hypothesis—are brought to notice early, so that the student is led to interpret electrical effects in terms of it. Then we come to definitions of potential and electric force and Cavendish's important demonstration of the law of the inverse square is given. Various necessary theorems concerning potential and lines and tubes of electric force are then stated in a clear and useful form. A good section on modern sensitive electroscopes such as those of C. T. R. Wilson follows, and Dolezalek's form of quadrant electrometer is described. The chapter concludes with a theoretical discussion of dielectrics, but nothing is said about the important qualities of absorption or energy dissipation or the changes which variation of temperature and frequency bring about.

Chapter IV. discusses electric current, its generation and measurement. Standard cells and galvanometers claim a brief notice, as also the laws of resistance, Joule's law, and the measurement of resistance are then discussed; but we miss

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information which might show the student how to calculate the resistance of complicated networks of conductors or how to determine the current in any branch.

This needs nothing but a simple modification of Kirchhoff's laws and a little knowledge of determinants. A short section on the measurement of dielectric constants and one on platinum thermometry conclude this chapter. Chapter V. on the magnetic effect of currents is a well-arranged chapter, containing much useful information. The Einthoven galvanometer is mentioned and the Kelvin current balances.

The fundamental equations of the electromagnetic field are then explained and the meaning of the important quantity called the vector potential elucidated. A very good section is that on the mutual inductance of circular conductors.

Chapter VI. brings us to the subject of thermoelectricity and its laws. The Peltier and Kelvin (Thomson) effects are well explained. We have also a description of thermoelectric ammeters, so essential for the measurement of high frequency currents. In Chapter VIII. the important subject of the induction of electric currents is treated and the principles on which the inductance of electric circuits can be calculated is expounded. This chapter will be particularly useful to radiotelegraphists who are rather apt to be contented with a formula without much thought as to how it is derived. Various methods of measuring inductances are given, and the rules appertaining to circuits containing capacity and inductance. The construction of induction coils is briefly mentioned, and a section devoted to the absolute determination of electrical resistance and capacity as well as the ratio of the electrostatic and electromagnetic units.

Chapter IX. on Applied Electricity imparts elementary information on the subject of dynamos, motors, and transformers.

With Chapter X., on Electrolysis, we enter that portion of the book more particularly concerned with modern views and recent knowledge.

The laws of electrolysis and the motion of ions in electrolytes are concisely explained, and the manner in which experiment can be made to yield information as to ionic velocities. This leads to a discussion of the theory of primary and secondary cells and the conductivity of electrolytes. The student will find this chapter particularly useful as a compendium of recent knowledge.

Chapter XI. introduces the subject of electric oscillations, electric resonance and decrement. The discussion of the subject of resonance curves and methods of and formulæ for obtaining from them a knowledge of the decrement of the circuit is very complete and excellent.

The practical information given here is well up to date, as shown by the fact that mention is made of the portable decremeter of the Marconi Company. The elementary laws of coupled circuits are given and the usual account of Hertz's experiments with the equations of the electromagnetic field round an oscillator.

The theory of electric wave propagation in free space and the electromagnetic theory of light is briefly treated on usual lines. This chapter forms a useful introduction to the scientific side of the subject of wireless telegraphy. The student who has the requisite mathematical equipment to read this chapter carefully will derive from it much valuable information that is not so fully given in other books.

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In Chapter XII. we have a very complete exposition of the phenomena of conduction of electricity through gases, and of the nature of the Röntgen rays. This chapter contains an able discussion of the recent important knowledge gained by the transmission of Röntgen rays through crystals. The extremely interesting and pioneer work of Professor Bragg and his son on this subject is very carefully explained, and the reader will find here a fascinating story of physical research unfolded.

We are only at the beginning of the information likely to be obtained as to the constitution of matter by the aid of these rays. The succeeding chapter follows up the subject with a discussion of the phenomena of radioactivity, and these two chapters alone form a storehouse of very valuable information as to recent physical research.

Although the subject of conduction through gases may seem rather remote from the work of the wireless telegraphist, yet there is much in this chapter of Mr. Pidduck's book which is relevant to it. Thus, for instance, the subject of the emission of ions from incandescent solids has great bearing on radiotelegraphy as it is the basis of operation of the Fleming valve receiver and its offspring the audion amplifier, which are of such importance as radiotelegraphic receivers. The Wehnelt cathode relay is another instance. No one is very likely to be able to make an improvement in these devices who has not acquired an advanced knowledge of the physical principles involved, and he will derive considerable assistance in that study from this chapter.

Another matter of special interest to the radiotelegraphist is the subject of sparking potentials, the theory of which is closely involved in that of gaseous conduction generally. It is dealt with as far as space permits in this same chapter. A brief section on photoelectricity has reference to a matter which is also of importance in connection with radiotelegraphy, as the atmospheric ionisation by sunlight brings into operation effects on long distance wireless which have been the subject of much discussion by experts.

The final chapter is devoted to a discussion of the electron theory and the explanation it is capable of affording as to metallic conduction and the propagation of electric effects through space. The Zeemann effect is also discussed and the general character of electrical and optical effects in moving media. Finally we have a brief reference to the theory of relativity and the new conception of quanta of energy introduced by Planck and Einstein.

Although the earlier portions of the book contain much elementary information unnecessary for the reader who has mastered the stock text-books on the subject, yet in the last five chapters Mr. Pidduck has given in a lucid and excellent form a very large amount of well-digested new information which is of great importance.

The book, therefore, can be confidently recommended to advanced students of electrical phenomena who are desirous of having in a compact and accessible form an account of recent additions to knowledge placed before them in a lucid and readable manner. The value of the book, however, would be greatly increased if the index were enlarged and rendered more complete. At present it is all too brief for the size and multiplicity of subjects treated.

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Administrative Notes

CHILI.

WE are advised by the Bureau of the International Telegraph Union, Radio Telegraphic Service, Berne, of the opening to public service early last April of the Radio Telegraphic Stations at Valparaiso, Llanquihue, Frutillar, and Punta Arenas.

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PORTUGAL.

The Government have published a decree ordering the service regulations annexed to the International Radio-Telegraph Convention to be put in force in the Portuguese Colonies.

As and from May 1st last the Portuguese Colonies will admit for transmission by their lines only private telegrams and radio telegrams, which are worded in clear Portuguese, French or English, and which contain the signature of the sender. However, the use of the various codes established by special arrangement is maintained for commercial telegrams. These are only accepted at sender's risk, and are submitted to censorship, which may cause delay, and no request for reimbursement will be considered. The use of the Italian language is allowed for telegrams between the Portuguese colonies and Italy, Lybia, and the Italian possessions in East Africa.

* * * * * *

SPAIN.

At the request of the Austro-Hungarian Ambassador in Madrid, as from June 15th in all stations authorised to carry on an international service, press telegrams will be accepted for Austria-Hungary *via* Buda Pest, at a charge of 14½ centimos (1½d.) per word.

Share Market Report

LONDON, *July 13th*, 1916.

As a result of the issue of the Marconi Company's Report and the Managing Director's speech at the Annual Meeting, the considerable progress which is being made by wireless has been very generally appreciated and has led to an all-round demand by the public for the shares of the various Marconi Companies.

Marconi Ordinary, £3 8s. 9d.; Marconi International Marine, £2 1s. 3d.; Marconi Preference, £2 16s. 3d.; American Marconi, 18s. 9d.; Canadian Marconi, 11s. 6d.; Spanish and General Wireless Trust, 12s.

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Wireless Telegraphy In the War

EXIT THE GERMAN "SPY SHIP."

THE extremely interesting case which culminated in an appeal against the condemnation by a decree of the Prize Court of the s.s. *Ophelia* has recently been concluded. In our issue of June last year we published a picture of Dr. Pfeiffer, the commanding officer of the vessel, in the act of giving his evidence before the Court, presided over by Sir Samuel Evans, and at that time some of our daily contemporaries were referring to the vessel as the "mystery ship."

We may recall to our readers the fact that this vessel was ostensibly a floating hospital and claimed the immunity accorded to such vessels under the provisions of Article X. of the Hague Convention, 1907, which laid down that "ships used solely "with a view to aiding the wounded, sick and shipwrecked, shall be respected and "cannot be captured." Actually she was proved to be a German spy utilising her immunity for signalling purposes. This fact was first brought out by Mr. J. A. Cox, the leading telegraphist on H.M.S. *Lawford*, to whose skill and vigilance the detection of this piece of German treachery was originally due.

After very careful sifting of evidence on the part of Sir Samuel Evans, the vessel was condemned by him, mainly on the grounds that the *Ophelia* never rendered the slightest assistance to any single wounded, sick or shipwrecked man; that her construction and equipment were totally unsuited to the purposes of a hospital ship; and that her officers were constantly in touch with German ships of war, receiving orders from them and carrying out such orders. This judgment was given on May 21st last year, and an appeal against it was carried to the Judicial Committee of the Privy Council, whose final judgment was promulgated on May 8th of this year.

Sir Arthur Channell, in delivering final judgment, emphasised at considerable length the great attention which had been paid to the signalling equipment of the ship, which included a special lengthening of her masts, for the express purpose, and with the actual effect, of extending the receiving capacity of her wireless installation. The learned President was totally unable to accept the ridiculous explanation of Dr. Pfeiffer that the vastly excessive supply of coloured signals, fired from a special kind of pistol, were intended to "illuminate the surface of the sea and assist in searching "at night for shipwrecked mariners or their corpses"! Moreover, their Lordships laid down that the Hague Convention says nothing to justify the transmission of

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messages (all of which when sent by a hospital ship must be of an innocent character) in a *secret code* as was done in the *Ophelia's* case. The destruction of the wireless codes, logs and other documents completed the chain of evidence which led the Court to confirm the original decision.

There is a touch of irony involved in the fact that since the original condemnation the vessel had been used by the British Admiralty, and has been destroyed by the Germans themselves.

DUPLICITY AT EVERY TURN.

Just after the final decision of the Court of Appeal in the case of the German spy-ship *Ophelia* came the trial of the case affecting the Norwegian ship *Bangor*, which was seized by H.M.S. *Bristol* in South American waters whilst acting as a supply ship to the German cruiser *Dresden*.

The story is worth telling, as an illustration of the devious ways which the Germans pursue for effecting their ends. The first act of the drama dates as far back as Christmas Day, 1914, when the *Bangor* sailed from Copenhagen on an apparently perfectly innocent voyage to New York. Once arrived in the United States, chameleon-like she changed her skin to suit her surroundings, and adopted the American name of *Seattle*. From New York she went to Baltimore, where she was joined by three men of German origin, one of whom was a wireless operator, who fixed up an installation as soon as the vessel was fairly at sea. The wireless code served out for use and generally employed was German, and the super-cargo, rejoicing in the name of Vielmetter, received, through the agency of the ship's wireless, instructions as to what course the captain was to take. Over and above the regular signal book there was a supplementary German secret private code.

As soon as H.M.S. *Bristol* had taken possession of the vessel—the capture being located not far off the Straits of Magellan—Vielmetter got rid of the codes by throwing them overboard, whilst one of his assistants, who had kept a record of the wireless messages received, destroyed the message register together with most of his other secret papers by fire. Vielmetter openly acknowledges that he understood the cargo on the *Bangor* (alias *Seattle*) to be intended for use by a vessel in the German Auxiliary Fleet, and said that he received his instructions both as to where to join and what procedure to follow from a Mr. E. Nordmann, an agent of the German Naval Attaché in New York. The owners of the vessel defended the case, not by denying the fact that she was a supply-ship for the *Dresden*, but on the grounds that the waters in which her capture was effected were territorial waters.

* * * * * *

ALPINE WARFARE.

Imitating their Allies on the Western front, the Austrians, doubtless led by officers from the nation with whom Italy is even yet not technically at war, hurled themselves upon the Italian advanced positions. Our gallant Allies, after a long and gallant struggle against the natural obstacles imposed by their unnatural frontier, had begun to impress them with the realisation of a serious menace, hence their elaborate winter preparation for an overwhelming offensive on the Mackensen-Hindenburg model. There is something extremely picturesque in this warfare

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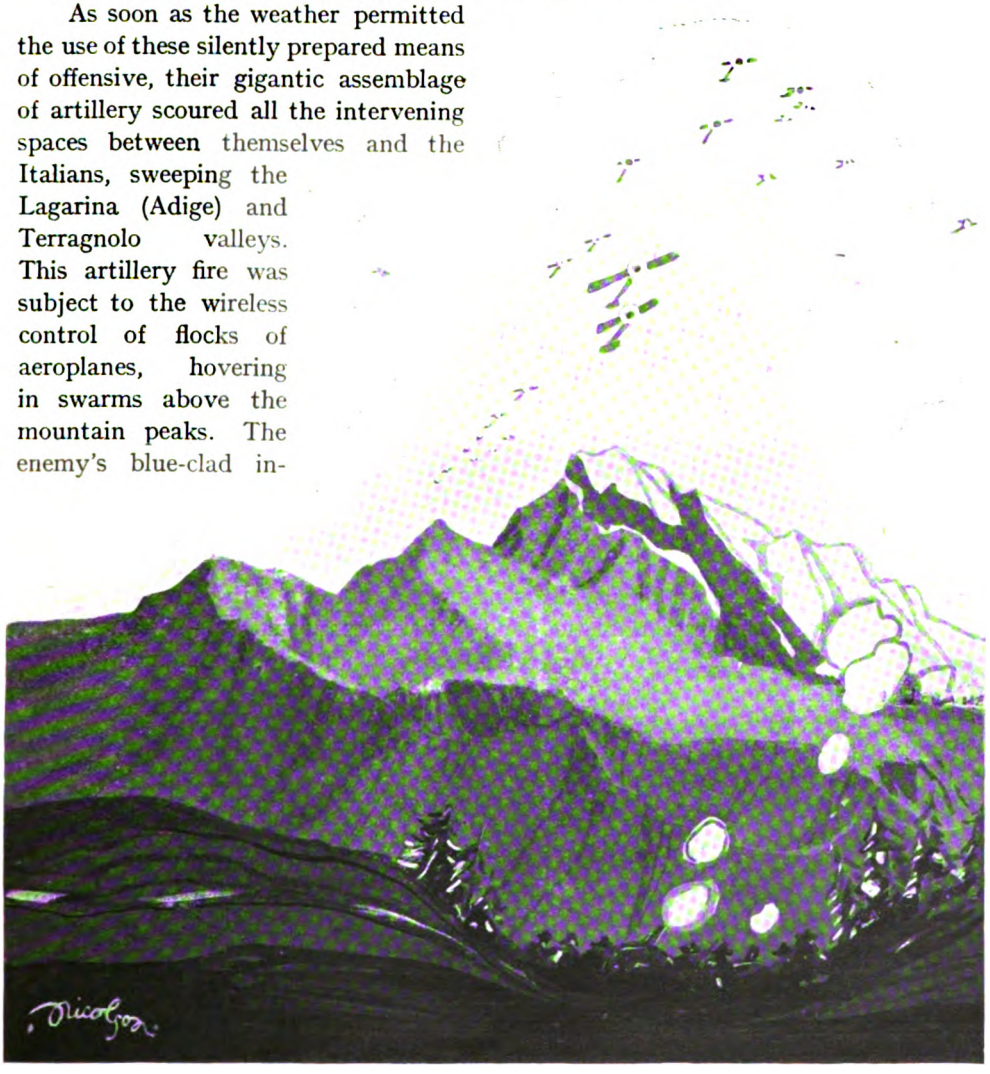
amongst the mountains, whose contours are in this district particularly abrupt and rugged. The almost total absence of roads renders peculiarly difficult the task of keeping the various hill-perched positions supplied with rations and munitions, whilst the nature of the terrain necessitates a reliance for communication upon wireless telegraphy almost to the exclusion of any other.

As might be expected from the army of the Motherland of Senatore Marconi, the Italian military forces are particularly well supplied and organised in this respect, and the enemy was obliged to counter the Italians' radiotelegraphic equipment before they could make headway against them.

The winter months were evidently extremely well utilised by the Austrians in this theatre of war, for their offensive revealed a massing of heavy guns upon craggy heights, on a scale not unjustly described as colossal.

As soon as the weather permitted the use of these silently prepared means of offensive, their gigantic assemblage of artillery scoured all the intervening spaces between themselves and the Italians, sweeping the Lagarina (Adige) and Terragnolo valleys. This artillery fire was subject to the wireless control of flocks of aeroplanes, hovering in swarms above the mountain peaks. The enemy's blue-clad in-



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fantry, after the way had been prepared for them by this hail of shells, swept on in thick formation and paid an enormous death toll at the mountain barriers. The Allies here, as on the French frontier, adopted the common-sense tactics of allowing the less easily held positions to fall *at a price*. That price was an extremely heavy one; it has been paid, and now the time has arrived when the dearly fought positions are once again being reft from them. Thanks to the brilliant Russian offensive and the gallantry of the Italian troops the Austrians are being obliged to evacuate what they had won at a much faster rate than they gained it.

* * * * * *

A CORNER OF THE VEIL LIFTED.

The Censor has lifted a corner of the veil covering British submarine exploits. Rudyard Kipling's articles on "The Trade" (as it is called) will be read by everyone, and the following narrative, contributed by Miss Jane Anderson, forms a fitting pendant to his stirring yarns.

A British submarine after contact with an enemy mine had to perform a 300-mile voyage before reaching port. It had suffered so severely from the resulting explosion that every man on board had been thrown upon his face, whilst the glass protecting the dials was shivered to pieces and rattled in splinters on the floor. One of the officers interviewed made the remark, "It was fine, d'you know, to see the "crew. They got on their feet and were at their stations before the commander "had time to give the order." Just as a man after a bad fall feels his corporal entity *seriatim* limb by limb in order to prove whether "anything is broken," so on board the submarine first one piece of machinery was tested and then another. As soon as the C.O. found that his motors would be able to bring him to the surface and had started them on the task his first care was to see if the wireless was working.

As our British "submariners" were slowly rising, their quickened ears strained to catch every sound, they could distinctly hear in the silence room "the noise "of the wireless sparking." The operator was testing it in preparation for possible use as soon as the surface of the sea was reached. The bow plating was buckled, two out of the three bow bulkheads were gone, and the rudder twisted awry. The man-of-war had become as defenceless as an unarmed tramp. In case of danger or distress their only resource lay in the hope that wireless would be able to summon help. But with true British grit no help was asked for; they pounded along "awash" under their own power, the waves breaking over the bridge and hammering on the solitary bulkhead. "And so," ended the officer, with a smile, "we came "home."

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WIRELESS AID IN TROPICAL WARFARE.

In a few pregnant words a newspaper correspondent with General Smuts draws one of those pictures which seem to impress themselves at once on the imagination. He is describing a sweeping movement being made across the plains, hills and forests through which the British forces from Rhodesia are advancing against German East Africa. The journalist who is accompanying this section of the expedition describes the chagrin of the British Imperial troopers at the fact that the German enemy abandons one position after another almost without fighting. The chief

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difficulty lies in the fact that the way forward has to be "cut through untravelled "bush, where the spoor of the latest armoured motor-car mingles with the footprints "of the ostrich and the eland. Men and animals all seem on the march together. "Overhead hover the aeroplanes, which keep within wireless call of the columns toiling "through the forest primeval."

In a recent issue we referred to the fact that enemy wireless was discovered in the midst of a North African desert, and discovered through the medium of scouting British aeroplanes in constant radio touch with one of our flying columns. In the above extract we have drawn for us a sketch of operations in East Africa under totally different conditions. *There* the forces of Nature set themselves against the growth of any kind of plant life; *here* the conditions are so favourable that plant life luxuriates in stupendous abundance. Under each condition man finds considerable difficulty in making his way, although for totally different reasons. But in each case invaluable aid is rendered him by his latest means for overcoming natural obstacles. In each case the advancing column, crawling painfully over the soil which seems to attempt to bar his progress, is watched over by soaring airmen, continually in touch with their less fortunate comrades below, by means of wireless. 'Tis an interesting chapter in the eternal struggle between man and nature.

War Notes

Kitchener's Wireless.

It is sometimes forgotten that the late Lord Kitchener received his appointment as Minister of State for War through the instrumentality of a wireless message, which reached him when he was actually on board a steamer bound for Calais. This message brought his lordship back to London to assume the direction of the British War Machine, which owes so much of its efficiency to him.

* * * * * *

A Naval Nickname.

The British Navy has long reduced signalling to a fine art, and now that wireless telegraphy has become so indispensable a feature in sea operations of every description, the British Tar has stamped his acceptance of the new science by endowing the "Chief Yeoman" of Wireless Signals with a nickname. This, which, in the first instance, was "sparker," has now evolved into "ferics," which is the navyese for atmospherics.

* * * * * *

Faith.

It is a curious fact that only "Landlubbers" were depressed by the first Admiralty despatch concerning the Jutland battle. As compared with sailors, we are "men of little faith"! The wireless operator on one of the units of England's Mercantile Marine reports that on handing his first wireless message to the Commander with the Admiralty text correctly rendered, the latter refused to publish it. His faith in the British Navy was not to be shaken, and only when a second wireless message came along with the later information, did he realise that the fault did not lie with the news, but with the somewhat inept expression thereof.

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A Wireless Army Car

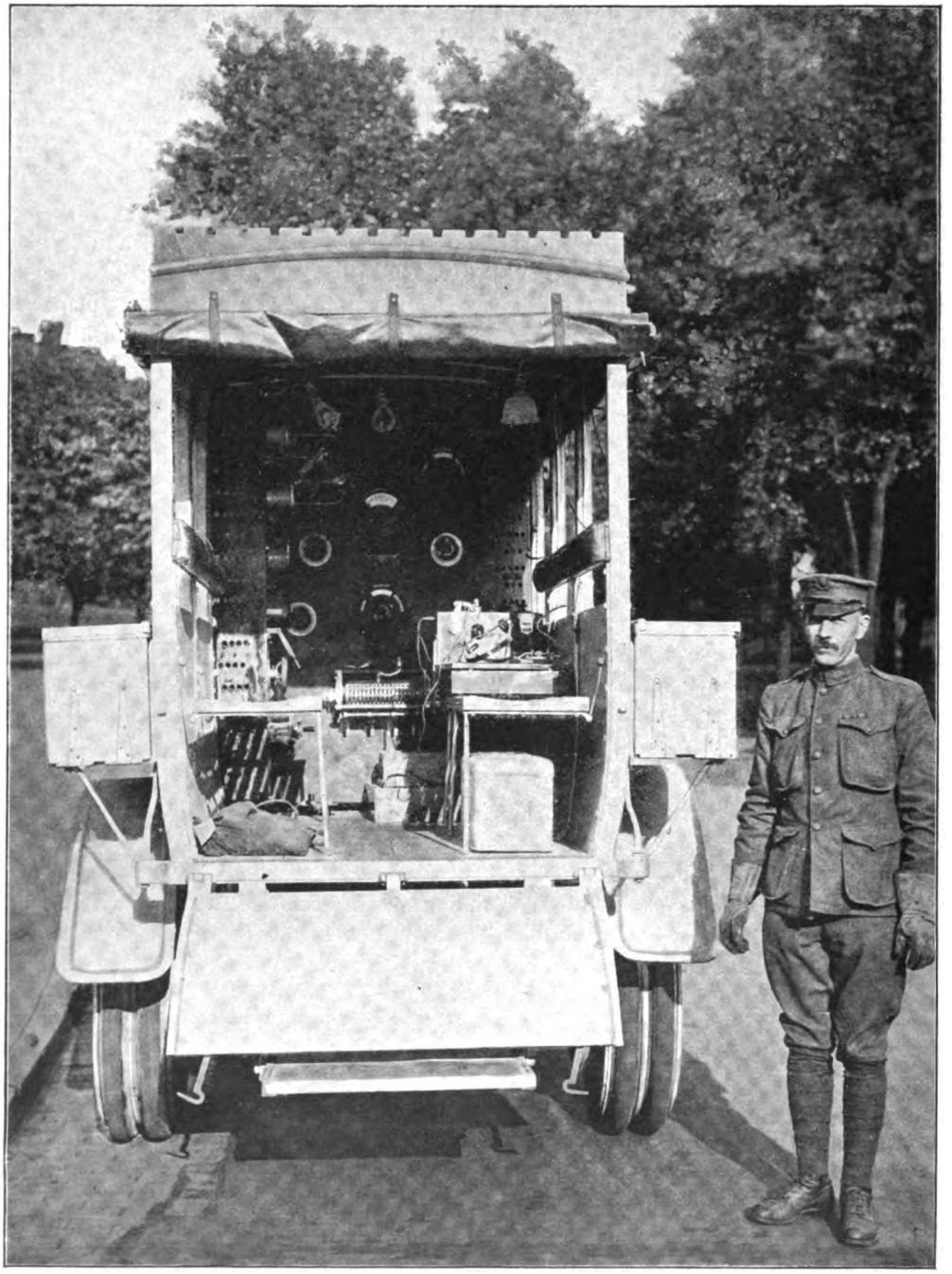

Photo by] [*Brown Bros., New York.*

AUTOMOBILE WIRELESS SET IN USE BY THE UNITED STATES ARMY. ITS CHIEF UTILITY LIES IN THE FACT THAT IT CAN BE MOVED RAPIDLY FROM ONE SPOT TO ANOTHER.

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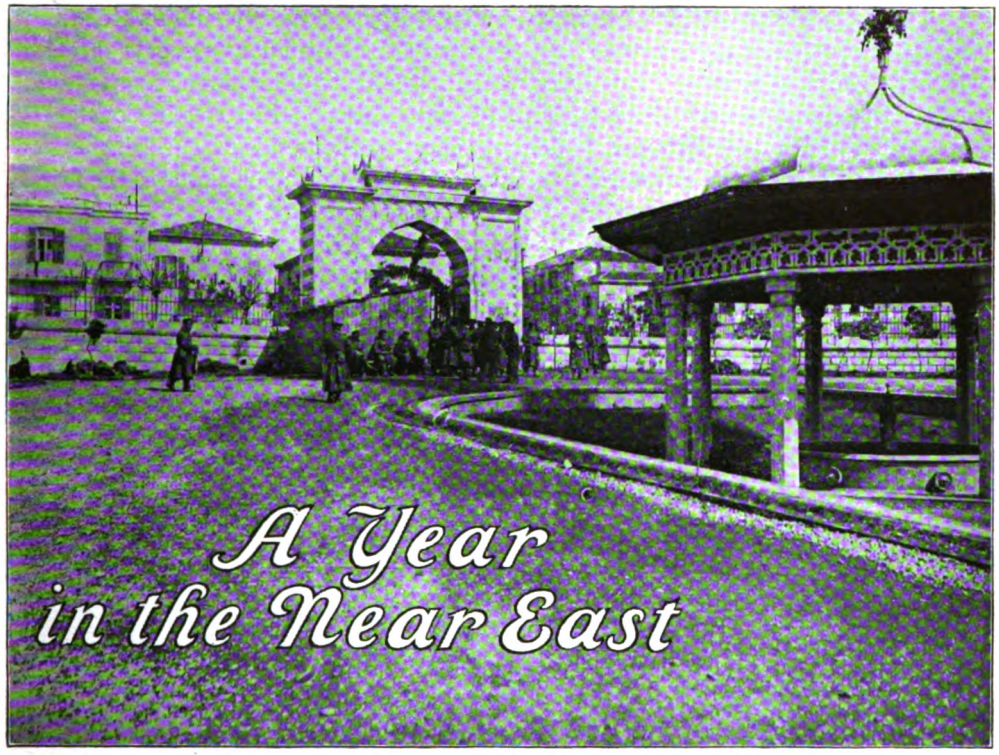

Some Recollections of Wireless Service on the Egyptian State Yacht

By PERCY W. HARRIS

With Illustrations by the Author

(*Continued from p.* 289.)

WRITING of guns and brigands reminds me of another little adventure when I found myself in a miniature hail of bullets. At the time we were lying off Thasos (the birthplace of St. Paul the Apostle) and I had received, the previous night, a message from Port Said saying that Janina had fallen. Thinking that the news would interest the islanders, an official had sent ashore to tell them, with the result that before long the inhabitants (mostly Greeks) were wild with excitement and joy. Guns were fired in the air, cheers arose in volleys and people could be descried running hither and thither on every side. Suddenly I heard whistling sounds around me; little splashes in the water showed that these were caused by bullets. It was evident that either by accident or malice guns were being fired at the yacht and it can be imagined that I lost no time in seeking cover!

NOTE.—Our headpiece photograph represents Bulgarian soldiers in the courtyard of a mosque in Salonika.

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The Balkan War to which I have referred will almost have been obliterated from the minds of most of my readers by the events of the stupendous struggle through which we are now passing. But in its way it was a big affair, involving Turkey, Greece, Bulgaria and Serbia, the last three being Allies then! I was in Constantinople when the Turkish Army was mobilised and saw thousands of Turkish soldiers in khaki march off to the war never to return. Later, I was much closer to the firing line at Salonika.

The Turkish inhabitants of Albania and parts of Thrace soon suffered terribly from the invading hordes of Greeks, Bulgarians and Serbs, and their brother Mohammedans in Egypt, hearing of their distress, begged the Khedive to succour them. With this object the *Mahroussa* was sent loaded with flour and provisions to Kavalla, now a Greek port but then in temporary possession of the Bulgarians. Kavalla had a particular interest for the Khedive as his famous ancestor Mohammed Ali, first

"KAVALLA . . . THEN IN TEMPORARY POSSESSION OF THE BULGARIANS."

Khedive of Egypt, was buried there; and further, he owned large estates in the neighbourhood. On arrival at the port some delays arose in obtaining permission from the Bulgarian authorities to land our cargo, and after a while the Commander of the port himself came out on a visit of inspection. I was fortunate enough to secure a snapshot of him just as he saluted our Commander at the top of the companion ladder.

Enquiries made by the officials of the Red Crescent Society, whom we carried with us (the Red Crescent Society is the Egyptian equivalent of our Red Cross), showed that hundreds of families were encamped on the seashore, having been driven out of their villages and their homes burned. It was necessary to do something at once, for Kavalla could not hold them all and many were suffering severely from exposure. The Greek priests were doing much for them, and after an interchange of telegrams it was decided that we should bring as many as we could away. Thenceforth we became a "rescue" ship and made several journeys to Kavalla, conveying

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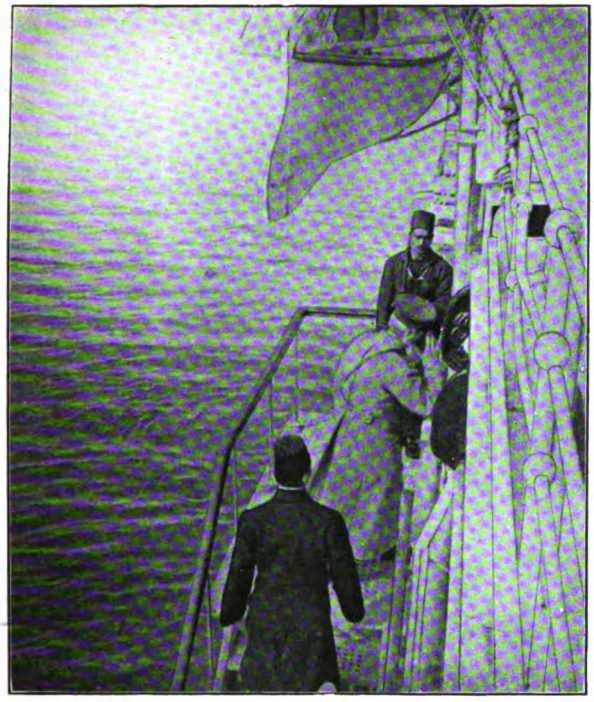
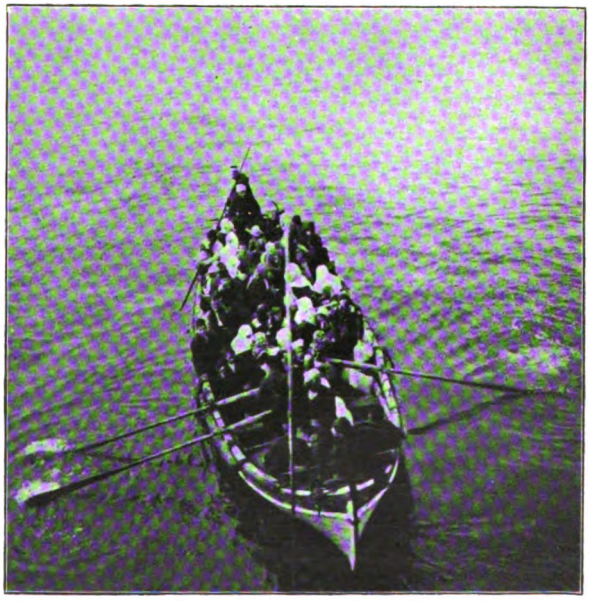


THE BULGARIAN COMMANDER'S VISIT AT SALONIKA.

the refugees either to Chanak in the Dardanelles, or else down to Dalamon and Egypt. On one of those expeditions we came perilously near shipwreck.

In England, Board of Trade regulations prevent a ship putting to sea overloaded or in a dangerous condition, but for the *Mahroussa* there were no regulations save those of the Khedive—and he was not particular. We had no lifebelts on board and the lifeboat accommodation barely sufficed for the officers, staff and crew. Further, we were not designed to carry cargo, the yacht being ballasted with concrete so as to keep her trim with the normal complement of passengers and crew—in all, two hundred.

Bearing this in mind, think of the misgivings which filled the hearts of the British members of the crew when hundreds of refugees with their personal effects were brought out from the shore in barges and commenced to scale the ladders at the ship's side. Barge after barge, packed with wretched humanity, arrived at the ship and a continuous stream of men, women and children loaded with bales and packages poured on to the decks. Swarthy Albanians in baggy trousers and bright-hued shirts, with wide scarves wound about their waists and knives of murderous appearance protruding; veiled Turkish women



HUNDREDS OF REFUGEES WERE BROUGHT FROM THE SHORE IN BARGES.

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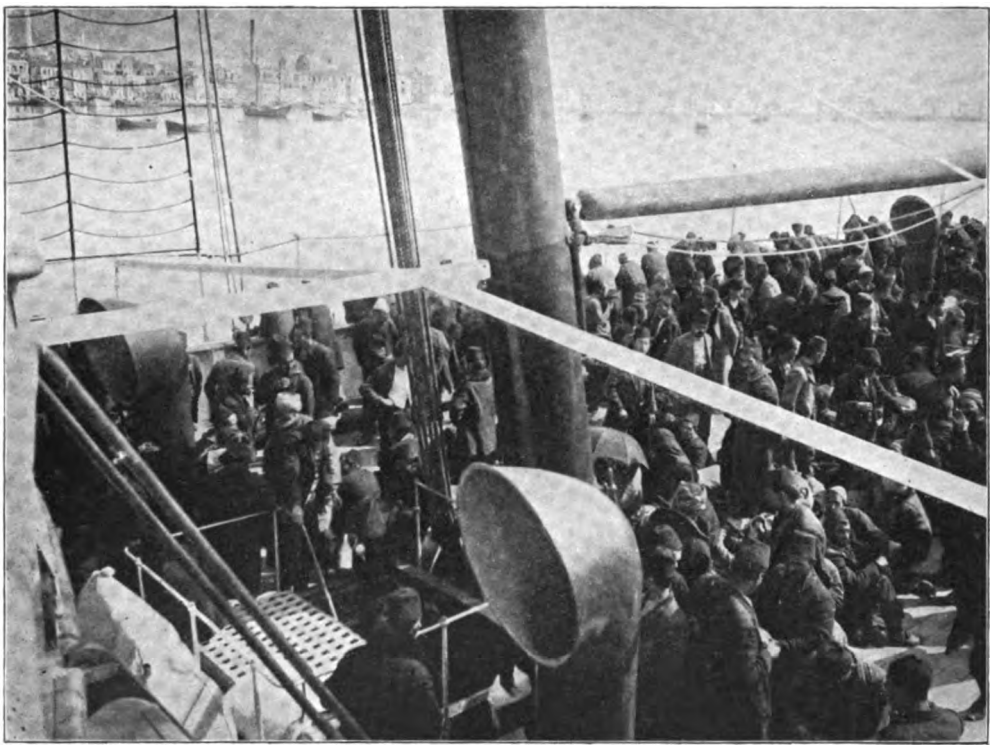

"BY MIDDAY ALMOST EVERY FOOT OF THE DECK WAS OCCUPIED."

draped in funereal black, children of twelve or thirteen, glancing timidly about them and trailing still younger brothers and sisters—in truth, a motley crowd, jostled one another up the ladders. As they set foot on deck all underwent a cursory examination by an Arab doctor and suspicious cases were turned aside for further inspection by other doctors on board. One side of the ship was set apart for the women and the other for the men. The luggage was tipped into the hold or piled fore and aft, and the men soon made themselves comfortable by sprawling on deck on the rugs and blankets they had brought with them, whilst the women huddled together in groups and squatted, Turkish fashion, wherever they could find shelter. By mid-day almost every foot of the deck was occupied and the pile of luggage on deck had grown to formidable proportions. Picking my way among the evil-smelling crowd, I sought out a Turkish official who was superintending the embarkation and enquired how many refugees had been taken aboard.

"Between seventeen and eighteen hundred," he answered. "We shall stop now."

Between seventeen and eighteen hundred souls besides officials and crew! Counting these we had fully two thousand. And this on a yacht designed to carry but two hundred people!

To make matters worse, outside of the harbour a heavy swell was running and a gale of wind sprang up directly we put to sea. Loaded almost to the water

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line and with a distinct list to port the *Mahroussa* staggered through the waves, great seas washing over her bows and drenching the terrified passengers, many of whom had never left land before. I have sailed in many ships on many seas and have stood the buffetings of the North Atlantic in its most angry winter moods, but never before had I experienced such a storm as howled around us that night, or such pitching and rolling as we endured. Sitting in my cabin through the night, and even with the telephones gripped tight to my head, I could hear groans from the poor refugees outside intermingled with the howling of the wind and sea. I expected every moment to have to send out the call of distress, but fortunately there was no need.

Three children were born on board that night.

When day dawned the storm abated somewhat, and the refugees were fed, but the seas were heavy and still drenched all those who were crowded together forward. An inspection revealed the loss of two boats and portions of the deck structures, whilst two ladders were found smashed to matchwood. Some of the rigging had also been carried away, but fortunately the aerial remained intact, to my great relief.

In due course we came to the Dardanelles and took shelter there, landing many of our passengers at Chanak. That night I slept as I had not slept for months, secure in the thought that we were once more anchored in calm waters.

After a few trips to Kavalla we were dispatched to Salonika on a similar errand of mercy, this time having to deal with the Greek authorities. Salonika is a wonderful old city (the Thessalonica of the Bible, as most readers will know), and had not long

SOME OF THE REFUGEE CHILDREN.

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been captured from the Turks. It yielded, as a matter of fact, with scarcely a struggle—but even the mosques were occupied by military guards. Some of the larger mosques were Byzantine churches from which the Mohammedans had removed the Christian emblems, and when we arrived they had just been changed back to Christian use. In one, the Church of St. George, I found the Greek priests officiating at hastily constructed wooden altars, covered with white sheets and guttering candles. In one corner I came across the tomb of a saint revealed through a hole in the wall opened that morning after having been bricked up four hundred years.

Late one afternoon, sitting "listening-in" to what might be happening in the surrounding ether, I heard a piping note like that of the Salonika Station but with a slightly different pitch. It grew louder rapidly and soon had reached that intensity in which the note ceases to be musical and changes to a violent pounding noise in the telephones. I then guessed that the signals must proceed from some neighbouring ship just arrived, and a step out on deck confirmed my belief. Within a couple of lengths of the *Mahroussa* lay another yacht, her hull also painted white, but differing from our ship in having pure white funnels. She proved to be the Greek royal yacht *Aphrodite*, bearing the King of Greece on a visit of inspection to his newly captured city.

The town was gaily decorated in honour of his coming, and we watched a launch take the royal visitor across to the quay. A day or two later, when the king was ashore and his yacht lay idle at anchor, the *Mahroussa* cast off her moorings and left for Egypt. And within an hour or so the triumphant king, after a brief taste of the joys of conquest, lay dead—shot through the heart by a cowardly assassin.

I left the *Mahroussa* shortly afterwards, at the expiration of my year's contract, as I had more than a suspicion that the Khedive disliked the British and all their ways. Later events showed how well founded was my belief.

Engineers and the War

ONE of our contemporaries, the *Electrical Times*, made in a recent issue a comment on the subject of the Jutland naval battle and the Honours List: two items which appeared in the Daily Press side by side. The Editor called attention to what we all know—namely, that upon the British Fleet depends the existence of our Empire, and he reminds his readers that the navy of to-day is the creation of engineers, that it is run mainly by engineers, and that thousands of these men heroically perished in order to bring the battle to a successful issue. Yet the Honours List in which a number of Tory "Tweedle-dums" were balanced with a number of Radical "Tweedle-dees" contained, "if we except a couple of Government and dockyard contractors, not an "engineer on the list." Seeing that three engineers (Col. C. F. Close, Lieut.-Col. N. M. Hemming and Capt. Riall Sankey) have received appointments as Companions of the Order of the Bath, the latter statement is perhaps a little too sweeping. But the substantial justice of our contemporary's remarks remains unaffected.

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NOTES OF THE MONTH

In our "Wireless and the War" columns for June we adverted to the naval disadvantage imposed upon Great Britain in her pre-war policy of totally neglecting the construction of rigid airships of the Zeppelin type. We showed how in connection with their radio-telegraphic apparatus these machines have proved of inestimable value to the enemy for scouting purposes. Our readers may have noticed that in the debate in Parliament on the occasion of the announcement by the Government of the formation of a new Air Board under the presidency of Lord Curzon, Mr. Winston Churchill, whose magnificent achievements in the administration of the Admiralty during the most critical phases of the war give him an unequalled authority, confirmed our views by speaking contemptuously of the Zeppelin as an instrument for war over land, but admitted that it "had unrivalled power for long-sustained reconnaissances at sea."

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We understand that the Post Office Provincial Superintendents and the Headquarters Staff of Traffic Managers have now been amalgamated into one establishment. This will be under the control of Mr. R. A. Dalzell, who will bear the title of Chief Inspector of Telegraph and Telephone Traffic. His two principal assistants will be Mr. L. Harvey Lowe, late Deputy Controller of the London Telephone Services, and Mr. J. Lee, with the title of Deputy Chief Inspector of Telegraph and Telephone Traffic. Mr. W. A. Valentine, late Provincial Superintendent, has been appointed Deputy Controller of the London Telephone Service.

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Apropos of the world-wide nature of our circulation, a reader-correspondent in Sioux City, Iowa, U.S.A., has sent us an interesting cutting from a newspaper in Omaha describing an American Amateur Radio Station. Messrs. W. C. Reinhardt and B. M. Bryce are the makers, as well as owners and manipulators of the installation, which claims a radius of nearly 1,000 miles. To use an appropriate Americanism, this is "some" station, and speaks eloquently of the skill, as well as of the enthusiasm, of the young telegraphists.

* * * * * *

The determination of the difference in longitude between Paris and Washington with the aid of wireless telegraphy, which has been in progress since October, 1913, has been completed. The distance between the stations is 6,175 km. The result, expressed in terms of time, is 5 hours 17 minutes 35·67 seconds, and has a probable accuracy of the order of 0·01 second.

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To Our Readers

CHARLES KINGSLEY introduces into one of his novels a character of a somewhat dubious status who when interrogated by a personage in authority proclaimed himself as "a man of no country." The interlocutor justly avowed himself as intensely suspicious of anyone who so classifies himself. The period during which Kingsley was writing saw the rise and growth of the "Manchester School" with its contemporaneous cult of "Internationalism." The "narrow boundaries which separate race from race" were to be swept away, and patriotism was to be coterminous with the orbit of the inhabited world. The aim of civilisation was to be directed towards destroying national peculiarities, towards bringing people of every clime to the same dull level, towards forcing every human being into an identical mould. Thank heaven, these ideals have vanished! With all its vicious tendencies, the *Deutschland über Alles* of Germany is better than such Internationalism. Of course, this precious doctrine bore within it its own destruction. Your Internationalism can no more turn an Englishman into a Frenchman, or a Frenchman into an American Indian, than it can turn a woman into a man by merely robing her in the garments of the sterner sex. A sane patriotism has taken its place, and one of the strongest points in favour of the Allies is the co-operation for a common end of the Latin, Slav and Anglo-Saxon races, each with its own national peculiarities, national aims and national ideals.

The sciences owe much to the fact that their eminent men focus upon their labours not only the attributes of their own personality, but those of the race to which they belong. No science has attained its present condition solely on the initiative and investigations of pioneers belonging to any one nation. Take, for instance, Radio-telegraphy. A Danish investigator, Oersted, first showed the connection between electricity and magnetism; Ampère, Faraday and Henry, belonging to France, England and America respectively, extended the principles of the combined science. Clerk-Maxwell and Hertz, working the one in England, the other in Germany, demonstrated the relation between electricity and light. Professor Branly, of France, Sir Oliver Lodge, of England, and Professor Righi, of Italy, followed upon similar lines. The science was ultimately brought to a practical issue by the crowning discoveries of Senatore Marconi. The latter, himself partly of British and partly of Italian parentage, has divided his labours between an English and an Italian *milieu*. Internationalism in the Manchester sense is not responsible for any of this; Radio-telegraphy is the product of the combined working of the choicest brains of separate nations and

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dissimilar races. It is hardly too much to say that had it not been for these variations the results obtained would have fallen far short of the progress actually made. This is patriotism *in excelsis* as opposed to Manchester internationalism.

At various periods mistaken enthusiasts have endeavoured to introduce a single international language to take the place, for certain purposes, of the various tongues employed by people of different races. The idea is as old as the story of the tower of Babel, but it is none the less erroneous. The peculiarities of the national spirit of the various races find far more assistance than hindrance from using a language specifically adapted to its own needs. The fact that Latin was employed as a world-wide medium during the Middle Ages furnishes really but a false analogy. The more highly educated moderns can understand most of the leading languages sufficiently to comprehend the main drift of any printed exposition. But when an applied science begins to make a really wide appeal it becomes necessary to make provision for the general reading public. Such a stage has now been reached in wireless telegraphy, and the appeal made by our magazine has become so wide that we find ourselves met with a demand for its appearance in other than an English form. The interest taken in the subject by Spain, Portugal and the great Ibero-American Republics of the New World has induced us to make a start by issuing THE WIRELESS WORLD in Spanish and Portuguese as well as in English. All the preliminary steps have been taken, and not many weeks are likely to elapse before Spanish and Portuguese readers will find our new monthly issues available in their native tongue. The Editorship will be undertaken by the well-known *littérateur* Señor Enrique Perez, and the edition will contain all the important items of the English magazine, together with some special features of its own. Such a step in the " piping times of peace " would have constituted a bold and enterprising venture: this terrible world-war adds immensely to our difficulties, and nothing but an overwhelming sense of the urgency of the demand would have induced us to take such action under present conditions. We feel sure that we may reckon on the co-operation of our readers for giving the maximum amount of publicity possible to our new venture, and launch our enterprise in certain reliance upon that kindly co-operation to which in the past we ourselves have owed so much.

The Editor

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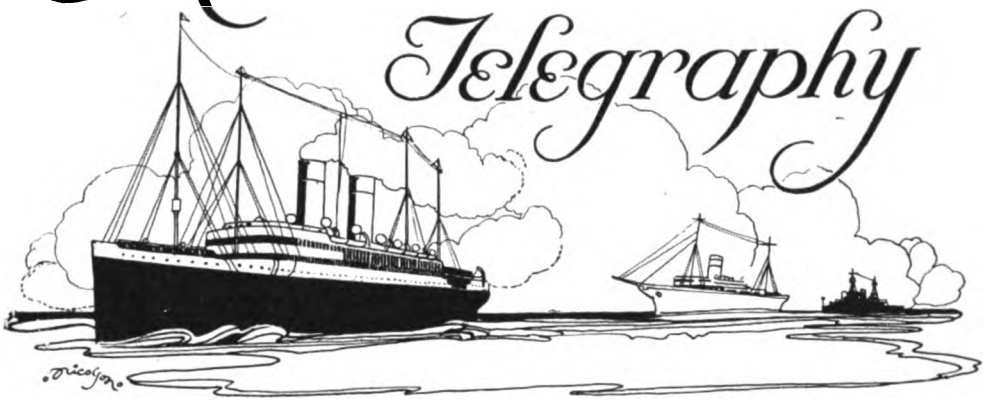
Maritime Wireless Telegraphy



Broken Shaft Repaired in Mid-Ocean.

A WIRELESS message received recently at Sydney, New South Wales, from Rabaul records the fine work performed by the officers and engineers of the steamer *Pukaki*, which was adrift in the Pacific Ocean with a broken tail shaft for a period of forty-two days. By improvising his sails the captain managed to navigate the vessel into the Doldrums in order to obviate the chance of drifting on to one of the numerous islands. Fortunately the steamer had a spare tail shaft on board, and when the weather was fine enough the engineers began their task. It was found, however, that the spare shaft was a misfit, and there was no alternative but to set to work with hammers, chisels and files to reduce the shaft to the required size. Eight days elapsed before it was put in position and the propeller fitted on, which enabled her to reach the port of Rabaul.

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French Schooner Sunk.

Wireless telegraphy is steadily fulfilling its uses. The Portuguese steamer *San Miguel* sent the following wireless message : " French schooner *St. Louis* (ex *Johanna*) was sunk on May the 28th. Crew landed." Thus through the medium of the ether, not only were the owners advised of the loss of their ship, but the relatives of the crew were informed of the safety of their friends.

* * * * * *

A Liner to the Rescue.

When the passenger ship *Eugène Pereire* arrived at Algiers recently she reported that during the crossing she received a wireless message from a British steamer saying that it was threatened by a submarine, and asking for assistance. The captain altered his course and proceeded to the spot indicated, at full speed. On arrival, however, the captain of the British steamer advised him that the submarine had not carried out its threat, having doubtless understood the danger which it would run if the *Eugène Pereire* arrived.

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SPAIN RECORDS A CALL.

Quite recently the wireless station at Cape Finisterre reported that it received a wireless call from a ship, whose initials, apparently, were British, demanding help, as she was being pursued by a German submarine. Her position was 10.31 West and 43.18 North—that is, about 25 miles off Cape Villano. She was bound southward, her speed being twelve knots. At two o'clock the same afternoon the steamer reported that she had escaped from the submarine, which fired three shots without doing any damage, and then disappeared. It is an interesting fact that, by the aid of wireless telegraphy, throughout the whole course of her trouble she was able to keep in touch with land.

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U.S.S. *Tennessee.*

Many of our readers will no doubt recollect reading of the Pan-American Conference recently held at Buenos Aires. The United States Commission returned from the Conference in the battleship *Tennessee*, which proceeded home *via* the West Coast of South America. It will be remembered that the members of the Commission refused to land at Callao, Peru, on account of the alleged existence of the bubonic plague at that port. This incident was the more regrettable in view of the fact that the Peruvian Government had spent a considerable sum of money in making preparation for the welcome of their guests. Our contemporary, the *South American Journal*, quoting the *West Coast Leader*, of Peru, states " if the plea of sanitary conditions is " to be regarded as valid . . . then a highly reprehensible error was committed " in the failure of the *Tennessee* to secure full information regarding the state of the " port before arrival. The cruiser was constantly in wireless communication with " Lima from the time she sailed from Valparaiso."

* * * * * *

ANTARCTIC RELIEF EXPEDITION SHIP.

An Uruguayan steam trawler built in 1906 for the North Sea fishing fleet was fitted out, and manned with a crew of twenty-six including a doctor, as a relief ship for the members of the Shackleton Expedition marooned on Elephant Island. The trawler, which is named *Instituto Pesca*, was lent by the Uruguayan Government, and was accompanied as far as the Falkland Islands by the British auxiliary cruiser *Macedonia*, one of the latter's officers accompanying the expedition to Elephant Island. The auxiliary cruiser stationed herself midway between the Falklands and Elephant Island, in order that wireless communication might be maintained with the expedition. A wireless telegram has been received at Monte Video from the Falkland Islands announcing that the trawler had arrived there and proceeded immediately to Elephant Island. We are sorry to say that the relief expedition has been a failure. The *Instituto Pesca* got to within twenty miles of Elephant Island, but she then encountered such a large quantity of dense pack-ice that she was forced to turn back. Sir Ernest Shackleton, who accompanied her, stated that it would require a wooden ship of greater resistance and different build to successfully cut a way through the ice. The captain of the whaler, however, sent a wireless to the Uruguayan Government announcing his decision to continue his efforts in the work of rescue. The damage to his boat is to be first repaired.

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The Progress of Wireless in Australasia

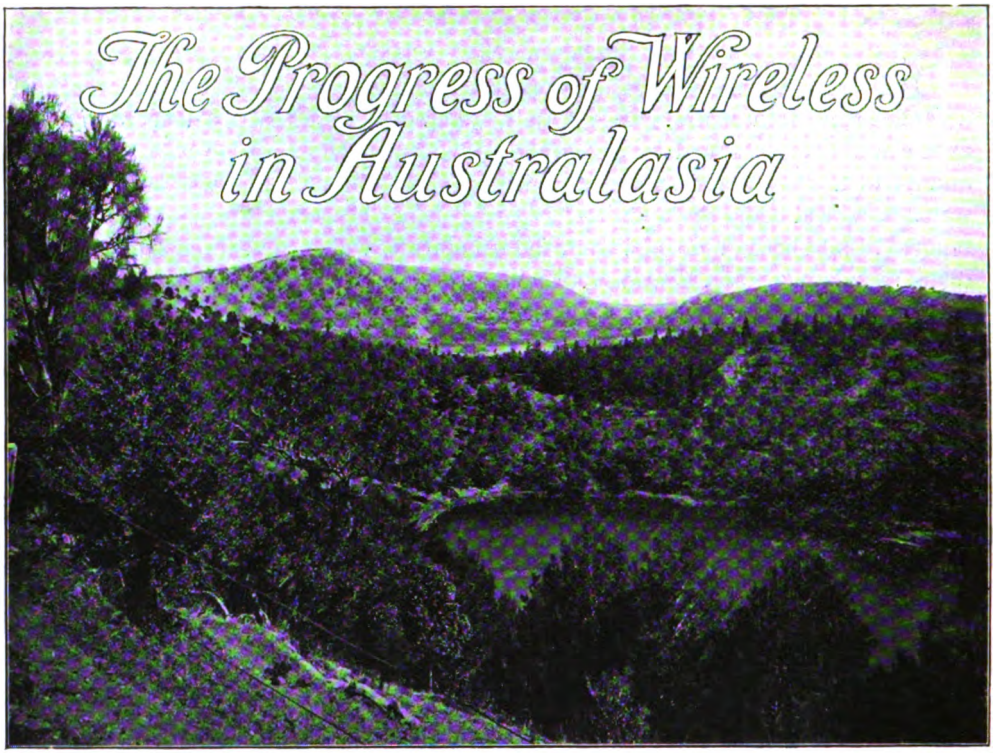

Photo. by] [*Giles' Photo Agency.*

THIS PHOTOGRAPH GIVES A GOOD IDEA OF THE TYPE OF BUSH COUNTRY IN AUSTRALIA.

A Story of Troubles Overcome.

The introduction and development of wireless telegraphy in Australasia have been accompanied by exceptional difficulties, and have taken that part of the Empire through troublous times. The story of those difficulties and the manner in which they have been overcome is unique, and as it has not been related before, we believe it will interest our readers.

The first attempts to introduce the benefit of Senatore Marconi's invention in Australasia were made entirely upon the initiative and at the expense of the Marconi Company, who, in 1905, sent out a representative in the person of Captain Walker, accompanied by two assistants, Messrs. H. M. Dowsett and H. Densham.

Captain Walker, upon arrival, introduced himself to the Governor and the Ministers and officials of the Australian Government, who were all keenly interested in the achievements of Senatore Marconi up to that time, and immediately saw the possibility, as well as the necessity, of Marconi communication in the Antipodes.

In order that the Government and the people of Australia might have practical evidence of the possibilities of this form of communication, Captain Walker proceeded with the erection of two Marconi installations, which had been sent out from England. One of these stations was erected at Point Lonsdale in Victoria, and the other near Devonport in Tasmania. Communication was established and maintained with perfect ease. The reasons for selecting these points for the

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demonstrations were probably the importance of communication between Tasmania and the mainland, the fact that the Tasmanian cable lies on troublesome ground, which gives additional difficulties in maintenance, and that Point Lonsdale in Victoria was close to Melbourne, the seat of government.

Captain Walker also proceeded to New Zealand, in which country the Australian demonstrations had been followed with great interest. He thoroughly discussed the possibilities with the New Zealand Government, and the Marconi Company, expecting that its apparatus would be required, left the stations standing idle in Victoria and Tasmania.

The next scene opens with a conference in Melbourne in the year 1909, at which a resolution was carried to the effect that a comprehensive scheme of wireless communication for Australia, New Zealand, and the surrounding islands should be drawn up and proceeded with. But alterations of policy occurred before the scheme was put into operation.

Australia and New Zealand were still unprovided with the means of wireless communication ; but the former once more made a start when Admiral Sir Reginald Henderson was called in to investigate and report upon the naval defence of the country. Admiral Henderson's report was published a few years ago, and therein will be found a complete scheme for wireless communication for Australia, both

Photo. by] [*Hardie.*

A PANORAMIC VIEW OF SYDNEY, LOOKING FROM THE HOTEL AUSTRALIA. THE BUILDING WITH THE TOWER, ON THE LEFT, IS THE GENERAL POST OFFICE.

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SKETCH MAP SHOWING THE POSITIONS OF THE FIRST TWO MARCONI INSTALLATIONS.

from the naval and commercial standpoints. Although Admiral Henderson's scheme has not been closely followed, the location of some of the existing stations appears to be based on his recommendations.

We now come to the Imperial Conference which was held in London in 1911, at which a proposal was brought forward for providing wireless communication between all parts of our Empire. The proposal was favourably received at the Conference, but the Prime Minister of Australia stated that he could not commit his country to any definite plan; if a chain of Imperial Stations were established they would provide a station in Australia to connect with the chain.

About this time, a step, which appeared to be based on the recommendations of Admiral Henderson, was taken both in Australia and New Zealand, and was the first serious attempt to provide the long-delayed facilities. The Australian and New Zealand Governments called for tenders for the erection of two medium-power wireless stations in each country. There were but two companies capable of undertaking such work—one British and the other German: the former, of course, was the Marconi Company of London, and the latter the Telefunken Company of Berlin. The German company apparently had cast longing eyes in the direction of Australasia, and decided to secure that contract at all costs. Knowing German methods as we know them now, it is not difficult to understand what happened. The Telefunken Company tendered such a low price that the British Company was unable to compete.

The German tender was accepted in both countries, and the stations were erected of German material by German engineers who assisted in selecting the sites.

In the meantime a company had been formed in Australia, with Australian capital, to purchase the rights of the German system. This company installed Telefunken apparatus on a few local ships and erected a small station in Sydney, which it operated under licence from the Government for communicating with ships at sea until such time as the high-power stations were completed. At the same time the Marconi Company had sent a representative to reside in Australia and watch its interests, whilst a number of local vessels were equipped with Marconi apparatus under his direction. The Marconi Company, considering that its patents were being

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infringed by the use of the German system, commenced a series of actions in the Australian and New Zealand Courts.

While the medium-power stations were being erected and the rival claims of the British and German systems were being placed before the Government, the Australian Government decided to engage a radiotelegraph engineer as its expert adviser. Unfortunately, in so doing further complications were introduced. The successful applicant had been engineer and technical adviser to a company which had recently been convicted in the High Court of Justice in England of infringing Marconi patents. On his arrival in Australia negotiations commenced for settling the difficulties with which the Government were faced; but these received a sudden check when the Government announced that its new engineer had produced a system of wireless telegraphy which was to be employed by them and was to make them independent of the patents of other systems. Hence the position became more complicated, particularly in view of the fact that before leaving England the Government Engineer had made a statement to the effect that from the year 1900 the whole of the subsequent development of wireless telegraphy was due to Senatore Marconi's invention, and all so-called systems of wireless telegraphy utilised his principles.

In view of the fact that the Marconi patent had been strongly upheld in the English and American Courts, and in face of the statement referred to, the Marconi Company notified the Government that its new system would be an infringement, and subsequently commenced an action in the Australian Courts.

Photo. by] [*Hardie.*

BOURKE STREET, MELBOURNE, FROM THE GENERAL POST OFFICE TOWER. THE LARGE BUILDING AT THE FAR END OF THE STREET IS THE FEDERAL PARLIAMENT HOUSE OF THE COMMONWEALTH GOVERNMENT.

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The Government, however, maintained that such was not the case, and proceeded to erect stations at several points round the coast of Australia. The first, opened at Melbourne in February, 1912, has some historical interest in being the beginning of a chain of low-power coastal stations encircling the entire island continent. The Melbourne station was opened officially by the Governor-General, Lord Denman, in the presence of the Ministers and officials of the Government and a large number of private guests, among whom were the representatives of the Marconi and Telefunken systems.

After this matters became more and more complicated between the Government and the Marconi Company, the Government and the Telefunken Company, and between the Marconi Company and the Telefunken Company. The Marconi Company's action proceeded very slowly, as for a period of over twelve months a preliminary action had to be fought, first before a judge in Chambers, then before the High Court of Australia, and finally before the Privy Council in England, before the Marconi Company secured the right of an ordinary litigant to inspect the defendant's apparatus. It is interesting to recollect in this connection that the Government, on the advice of its engineer, endeavoured to prevent this inspection on the ground that it would be prejudicial to the naval and military defence of the Commonwealth of Australia. Although such a contention could not be upheld before the Court, it delayed the action for at least twelve months.

The inspection was finally made, and the Marconi Company decided that its claim of infringement was justified. However, the Government subsequently called in another expert adviser, who said there was no infringement! Thus the position was not relieved on either side, and the action proceeded; but subsequent negotiations enabled a solution to be arrived at just prior to the outbreak of the

Photo. by] [*H. J. Shepstone*

LAMBTON QUAY, WELLINGTON, NEW ZEALAND.

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Photo. by] [*Valentine.*

GENERAL VIEW OF WELLINGTON FROM THE WHARF. THE LARGE BUILDING IN THE CENTRE OF THE PICTURE IS THE GENERAL POST OFFICE.

European war. The Government acquired the right of user for certain purposes of existing Marconi patents, while the company withdrew its actions and received a payment of £5,000 under the agreement.

In the meantime the medium-power stations were being completed by the Telefunken Company, and the New Zealand Government had erected also two low-power stations at Wellington and Auckland.

Another development had now arisen in the formation of a new Australian company, which purchased the whole of the existing and future rights in Australasia of the Marconi Company and the Australasian Wireless Company. This new company adopted the name of Amalgamated Wireless (Australasia), Limited, and carries on the work of the two previous companies. It has a capital of £140,000, of which originally half was to be British and half Australian; but, in order to relieve certain financial obligations of the Australian Wireless Company, the Telefunken Company became a shareholder to the extent of 8 per cent. of the capital, which, therefore, was distributed in the following relation: 50 per cent. British, 42 per cent. Australian, and 8 per cent. German. The last fortunately has now been entirely removed with the aid of the Government.

With the formation of this new company and the settlement of the Marconi action against the Government, the wireless position was very much relieved, and Australia is now fortunately placed in having in the hands of an Australian company the whole present and future developments of the world's leading systems, and particularly in having secured itself against the further intrusion of a German company.

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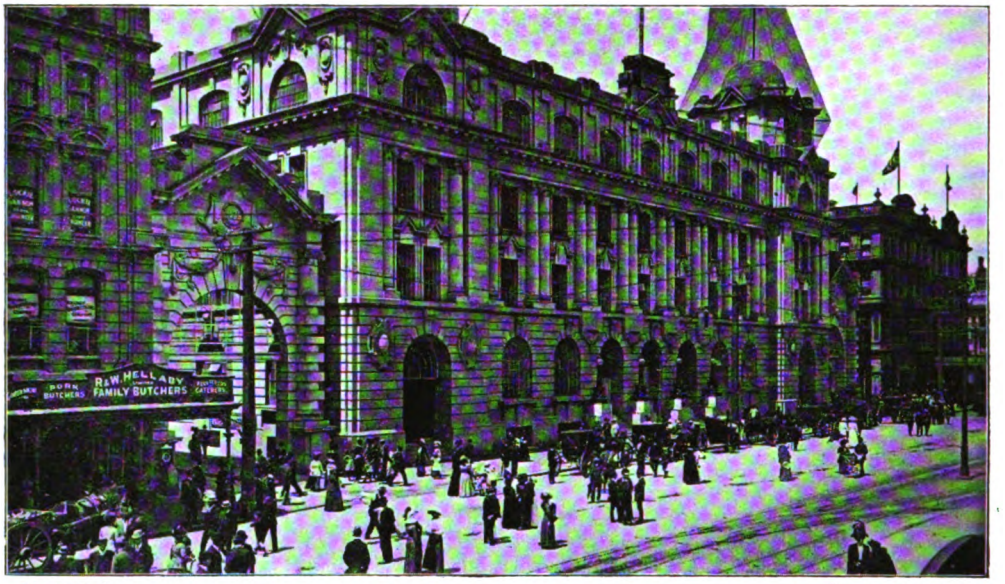

Photo. by] [*H. J. Shepston.*

THE POST OFFICE, AUCKLAND. THE MAST SUPPORTING THE WIRELESS AERIALS CAN JUST BE SEEN ON THE CUPOLA AT THE RIGHT OF THE BUILDING.

During the time with which we have been dealing the nucleus of the Australian Navy had been established and developed to the point at which the Commonwealth became the possessor of a first-class battle cruiser, three light cruisers, three torpedo-boat destroyers and two submarines.

The wireless telegraphic requirements of the Australian Naval Service were attended to by a branch of that service which worked independently of the other Government service, and it is worthy of particular notice that the naval branch, while steadily progressing along its own lines, did not become embroiled in any of the troubles and difficulties which surrounded the other wireless ventures.

Upon the outbreak of war in August, 1914, the Naval Department was called upon to extend its wireless telegraphic service very rapidly. This extension demanded hurried mobilisation of all its resources, and the closest co-operation with other wireless telegraphic organisations in the country. The Naval Department found the Amalgamated Wireless Company ready and willing to assist to their utmost, and it was largely due to the good relations which had always existed that all obstacles were overcome, and the extraordinary demands of war service were rapidly filled.

About the same time the Government had appointed a Commissioner to examine and report upon the business working in the various branches of the Postmaster-General's Department. Dealing with wireless telegraphy, this Commissioner found that the service was burdened with difficulties which arose from the antagonism of that branch of the Postal Department to the wireless telegraphic companies, and some friction which existed between it and other Government Departments. In the Commissioner's report he pointed out also that there was duplication of

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expense in having wireless telegraphy under the divided control of the Navy and the Post Office; in view of the supreme importance of naval work, and of the fact that the naval branch had not suffered disabilities in other directions, he recommended that the two wireless organisations should be combined and placed under the control of the Naval Board. This change was effected shortly afterwards, and subsequently the engineer who had acted for the Postal Department retired from the Government service.

From the foregoing it can be seen that wireless telegraphic development in Australia has been hampered by many complications, but that most of the difficulties have been overcome, and the changes which have taken place have removed the cause of the greater troubles, now leaving the field clear for development along progressive lines. With proper co-operation between the Government and the companies (which have been largely instrumental in bringing this great and useful art to its present valuable stage of development), Australia should advance along lines of steady progress in radio communication.

In a later article we propose to deal in detail with the wireless stations in Australasia.

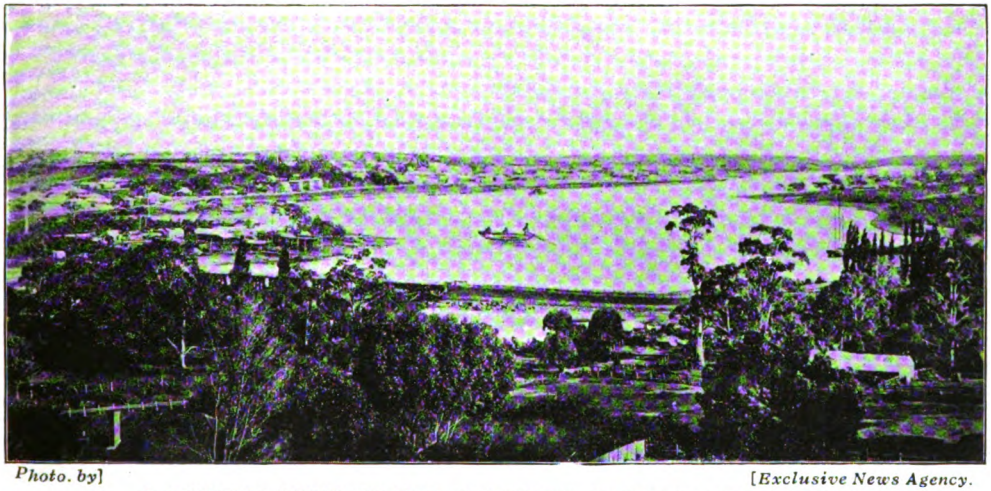

Photo. by] *[Exclusive News Agency.*

A GENERAL VIEW OF THE BEAUTIFUL HARBOUR OF SYDNEY.

Captain M. P. H. Riall Sankey, C.B., R.E.

CAPTAIN M. P. H. RIALL SANKEY, who was recently created Companion of the Order of the Bath, is a well-known figure in engineering and wireless circles. He is a member of the Institutions of Civil Engineers, of Mechanical Engineers and of Electrical Engineers, and on the Councils of the two former. For many years he was a Director of Willans & Robinson, Ltd., and on his retirement from his position with them, he became a consulting engineer with offices in Westminster. During recent years he has acted as Consulting Engineer to the Marconi Companies, and holds a prominent position on the Board of the "Wireless" and "International" Companies, besides being a Director of the "Wireless Press." Since the beginning of the present war he has, as Staff Captain, rendered valuable services both at home and on the Continent.

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Correspondence

SIR,—Your May edition of THE WIRELESS WORLD has just come to hand. In it I notice "Redax" when between Port Said and Malta has been unable to exchange signals with the former station, though he could pass signals to stations at a greater distance. When I was in charge of the s.s. *Canfield* in the Gulf of Mexico I had a lot of traffic to get through at night-time from Tampico, Mexico. Most of it was put through Tampa, Florida, about 1,000 miles away. Galveston, Texas, was only 400 miles away, but I could never get him, although I used to work to the ships in the Pacific. It was always a puzzle to me why this should be. The difference between "Redax" and myself was, I could work to the west and not to the north, while he could not work to west. I would very much like to know if it is possible to find out why this should happen. (Signed) "PUZZLED."

SIR,—I was very much interested in Mr. H. W. Pope's article in the May WIRELESS WORLD upon "How to Repair a Broken Magnetic Detector Spring." No doubt his valuable article was also appreciated by some of our other colleagues who have at some time or other had the misfortune to break the spring and have experienced great difficulty in repairing same.

I am one who has had the misfortune to break the spring, though the method I adopted in repairing it was slightly different from the one adopted by Mr. Pope.

The spring having broken I detached the mechanism, and with a pair of pliers I pulled out the broken spring. I found the end of the spring which is attached to the hook of the hub torn away to about ten inches. With a cold chisel I snapped the broken part off and punched a fresh hole in the spring, filing it oval shape to the size required, refixing it again on to the hook of the hub. I then unscrewed two of the fan-barrel pillars and placed the looped end of the spring over one of the remaining pillars. Having got the spring into position, I gripped the end of the hub to which the ratchet wheel is attached in the vice and, with the other end firmly secured, I turned the vice around, which had the effect of drawing the spring in until I was able to replace the two pillars I had previously removed. I released the vice gradually until the spring was bearing against the four pillars. This part of the operation was not effected without a good deal of physical exertion, due to the strength of the spring. Replacing the brass plate (with screws out) and placing ratchet wheel on top, together with the rest of the mechanism, I started to wind up, but found it necessary to remove one of the main pillars (C) owing to one of the barrel pillars catching against it. I then successfully wound up the spring, and as the barrel slowly revolved around I screwed down the brass plate with the four screws, passing the screws through the oval-shaped hole, which is placed near the ratchet wheel and pawl. Unwinding the spring again and removing the mechanism once more, I replaced the remaining main pillar (C) and, lastly, reconstructed the clockwork. Though I lost about ten inches of spring, I found the clockwork to run for about ninety minutes, having the satisfaction of repairing the spring with the whole mechanism complete. (Signed) L. C. RHODES.

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The Methods Employed for the Wireless Communication of Speech (v)

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institution of Electrical Engineers, on February 2nd, 1916.)

Summary of Results Achieved.

Before concluding, it may be as well to briefly summarise the most important results that have been achieved :—

About 1906 Fessenden telephoned wirelessly over distances up to about 20 miles, with successful results, employing a small H.F. alternator for generating the oscillations. (It has been stated that he covered much greater distances by the same method at a later date.) Since then numerous tests have been made from time to time, mainly with various forms of arc generator, and some fairly considerable distances have been bridged, the most notable being :—

Poulsen's communications over a distance of about 150 miles in 1908.

Majorana's over distances of about 250 miles, and recently Vanni's between Rome and Tripoli, about 600 miles.

In most cases, however, up to the present, the apparatus employed has hardly been in a fit state for commercial use, owing largely to the considerable amount of skilled attention that is required for its operation, accompanied by the difficulty in most cases of relaying the transmitting microphone on to the existing land lines, so as to enable it to be made use of by ordinary telephone subscribers.

Although up to the present time the various forms of arc generator have proved to be the most successful means of generating the required oscillatory currents, more especially when large powers have to be employed, they require on the whole much more attention in use than do the other methods.

Although high frequency alternators (including the Goldschmidt reflection alternator and similar machines) require little attention in running, beyond that usually given to moving machinery, and in spite of their being essentially a " power proposition " of the type one would think suitable for the results required, yet their great cost of construction and installation will most probably mitigate against their extensive adoption on a commercial scale, especially in view of the frequent and extensive repairs which, up to the present, have proved necessary in all machines of this type which have been constructed.

On the whole, the most promising pieces of apparatus yet devised seem to be the new " valve " or " vacuum " generators of the " Pliotron " type, as no care or attention whatever in maintenance should be required, and the constructional and installational cost should compare very favourably with machine generators—whether they will yet be available for larger powers of several hundred kilowatts remains to be seen—but, apart from actual constructional difficulties, there would seem to be little against their use for such outputs.

Their employment in wireless telephony is at present limited to the use of a large

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number in parallel, as has already been described. They have, however, enabled the record for long distance wireless telephone communications to be completely broken by the recent Transatlantic communications, and also those between Arlington and Honolulu (5,000 miles).

The employment of this type of apparatus should lead to considerable simplification of both transmitters and receivers, and would tend to make the apparatus suitable for use by "unskilled" persons, as practically nothing requires to be done beyond the initial switching on of the transmitter, while, in addition, the "microphone" problem of successfully modulating the radiated energy would be largely solved, as their very nature permits of such ready control of the oscillatory output by means of the potential of the "grid" electrode, and of the heating current of the filaments, as has been shown in the long distance communications referred to above, when the transmitter was relayed on to the land lines from New York.

As at the receiver the same type of instrument is available for amplification purposes it should easily be possible to relay the received speech on to land lines—an advantage which would be of considerable commercial value in connection with long oversea transmission.

One great difficulty that will have to be overcome if these generators are to be made for large powers is the disintegration of the filaments by the large oscillatory currents passing to and from it; but it is yet too early to speculate as to what effect this may have on the development of these oscillation generators.

In conclusion, wireless telephony, although an extremely interesting and important development of wireless signalling, will probably never have the extensive application that wireless telegraphy has already attained, but, nevertheless, it has a sphere of utility of its own when the apparatus can be rendered sufficiently "commercial" and reliable in form to be left in unskilled hands, just as can an ordinary wire telephone instrument. Probably its most important application will be to long distance oversea communications which cannot be carried on by submarine cables, its great advantage being that there is no *distortion* of the speech with distance (as in ordinary line transmissions) but merely *attenuation*. Its other important field will be in ship to ship and ship to shore communications for emergency, distress and similar purposes where the rapidity of communication of the desired intelligence (such as the position of a ship in distress, etc.) is all-important. For general communication purposes, however, between ships it is doubtful if it will ever supplant the wireless telegraph, but will remain as an auxiliary to it, for use on such occasions as above.

Finally, I should like to add that it has not been possible, in the limited time available, to do more than sketch out the merest outline of the subject before us; and also to take the opportunity of expressing my best thanks to the Marconi Company for the loan of photographs illustrating their apparatus, and to Messrs. Crosby, Lockwood & Co., for permission to reproduce certain illustrations appearing in their publications.

APPENDIX I.

CALCULATIONS FOR ALTERNATOR FOR THE DIRECT GENERATION OF CURRENTS OF WIRELESS FREQUENCY.

Suppose we require to generate a current having a frequency of 200,000 cycles

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per sec., which corresponds to a wave-length of 1,500 metres. Assuming an alternator of the usual type, we have: frequency = (revs. per sec. of the rotor) x (number of pairs of poles), so that if D is the diameter of the revolving rotor in feet, and P is the maximum permissible peripheral speed in feet per min. consistent with mechanical stability; we have N = revs. per min. $= \frac{P}{\pi D}$; if p is number of poles, and τ is the pole pitch in inches, or distance between adjacent poles measured round the circumference of the rotor, we have the frequency of the generated currents

$$n = \frac{P}{60.\pi.D} \times \frac{p}{2} = \frac{P.p}{120.\pi.D} \text{ and pole pitch } \tau = \frac{\pi.D.12}{p}, \text{ whence } n = \frac{P}{10\tau}$$

hence we see that the frequency is independent of the diameter of the armature and of the number of poles, and depends merely on the maximum peripheral speed and on the pole pitch. Returning to our example, we have for a frequency of 200,000 cycles, $\frac{P}{10\tau} = 200{,}000$ or $\tau = \frac{P}{2 \times 10^6}$. For ordinary slotted revolving armatures, with the conductors fastened in the slots, the maximum possible value of P may be taken as about 10,000 feet per min. Hence we have $\tau = \frac{10^4}{2 \times 10^6} = \frac{1}{200}$ ins., which can be seen at once to be quite out of the question for practical construction, at least, for anything more than microscopic outputs.

APPENDIX II.

Electric and Magnetic Deflections of Electrons in Valves.

If we have a particle of mass m, carrying a charge e, and moving with a velocity v, and subject it to the action of a magnetic field H at right angles to its direction of motion, the particle will be acted upon by a force $F = Hev$, which is at right angles to both its direction of motion and to the direction of the magnetic field. This will cause it to be deflected from its original direction of motion by an amount $= \frac{1}{2}Ft/m$, where t is the time that the particle is under the action of the force—*i.e.*, $t = 1/v$ where 1 = distance travelled. F = above force.

If now we apply an electrostatic field E the particle will be acted upon by a force $= Ee$, hence since the deflection that this produced depends merely on this force, and other constants, it is evident that the ratio of deflection produced by the magnetic field: deflection produced by electric field $= Hv/E$—that is to say, the greater the velocity of the electrons the greater will be the deflection produced by the magnetic field, as compared with that by the electric field; hence, if we have electrons of low velocity, the electric deflection will be more important, as compared with the magnetic, than it will be in the case of high velocity electrons.

Since, however, the electron is merely a charged particle of mass m and charge e, its velocity will depend on the voltage applied to the valve between the filament and the plate, and will increase with that voltage, since the force on a charged particle, as above, is Ve/d, where V/d is the potential gradient (volts per cm.), therefore it is to be expected that in valves in which the voltage applied between plate and filament is small (as is usually the case) the electric deflection of the electron stream will be the most useful one to employ.

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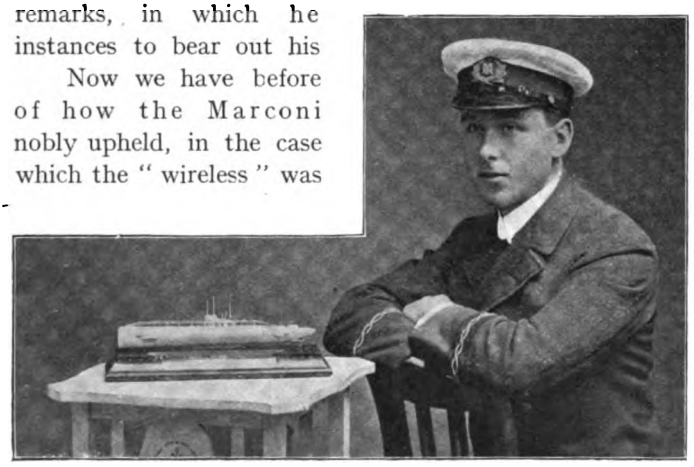
Among the Operators

" Gentlemen, I cannot close without reminding you that we have in our employ " in these perilous times some 2,000 young men almost continually on the seas, " and I think it speaks volumes for the great inherent qualities of our young men " from the moment they are given serious occupation and responsibility that in " no single instance has one of them been found wanting in the moment of peril."

Such were the words of Mr. Godfrey Isaacs, presiding at the recent annual meeting of the Marconi International Marine Communication Company, Limited. This tribute will come as no surprise to those who are acquainted with the staff of young men to whom has been allotted the task of handling the wireless apparatus on board the ships of the British mercantile marine. Almost daily we hear of deeds which in peace time would call forth praise in every newspaper, but which in the pressure of war news are frequently overlooked. On another page will be found a full report of Mr. Isaacs's subsequent remarks, in which he quoted a number of instances to bear out his previous statement. Now we have before us a further instance of how the Marconi tradition has been nobly upheld, in the case of the *San Melito*, on which the " wireless " was in charge of Mr. Owen Chick. We think we cannot do better than quote the following extracts from a special report which appeared in the *Westminster Gazette* for the 28th of June :—



OPERATOR OWEN CHICK WITH THE SILVER MODEL.

" An extremely " interesting and " touching little func- " tion took place yesterday at the Great Eastern Hotel, Liverpool Street, at which " the services of some members of the mercantile marine, that mighty service " whose silent labours and modest courage—so seldom publicly proclaimed, but " withal so vital to the nation's very existence—will stand out in bold relief " amidst the countless gallant deeds of the present war, met with well-merited and " tangible reward.

" The guests of honour were the captain and officers of the *San Melito*, one of " the great tankers of the Eagle Oil Transport fleet, launched at Jarrow in March, " 1914, and possessing an over-all length of 1,550 feet with a total dead-weight " carrying capacity of over 16,000 tons. On August the 21st last, whilst making " a journey to Mexico for the purpose of loading a cargo of oil fuel, she was suddenly " attacked in the Channel by a German submarine, which at a distance of 250 to " 300 yards opened fire on her without warning. The captain was struck by the " flying splinters of a shell which had struck the lower bridge and stunned for some

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" moments. But he gave the orders to ' Away, full speed ! ' notwithstanding the " fact that the submarine was flying the signal ' Abandon ship immediately.' For " full forty minutes shells flew all around the *San Melito*. But by consummate " skill and calm courage the crew, who stuck manfully to their post—especially " the chief officer, Mr. Piper, who took the wheel, and to whose steering the escape " was largely due—managed to save their boat.

" Such was the simple story of heroism—typical only of that which the whole " mercantile marine has displayed during the past twenty months—which was " unfolded yesterday to those who were privileged to be present at the Great " Eastern Hotel, when Captain J. D. Jackson and his gallant officers were each " presented with a cheque and a silver inkstand, wrought in the form of the model " of a German submarine, as a memento of one of the most desperate hours of their " lives, the money having been jointly subscribed by the Eagle Oil Transport Co., " Ltd., the Anglo-Mexican Petroleum Products Co., Ltd., Lloyds, and the War " Risks Clubs."

Mr. Chick in a report to the Marconi Company states : " I was very agreeably " surprised when asked to accept, in addition to a cheque, a beautifully executed " model in silver of an early type of U boat mounted on an ebony base bearing the " inscription : ' Mr. O. Chick, wireless operator, presented by the Eagle Oil Trans- " ' port Co. and the Anglo-Mexican Petroleum Products Co. as a memento of the " ' escape of the s.s. *San Melito* from a German submarine after being shelled for " ' forty minutes, August 21st, 1915.' "

Mr. Chick has been in the service of the Marconi Company since November, 1913, when he came up to London from his home at Boscombe for the purpose of joining the training establishment at Marconi House. He is twenty-four years old, and prior to his taking up present employment he held a position in the Traffic Department of the Bournemouth Corporation Tramways. After his appointment to the operating staff in January, 1914, he made his first voyage to sea on the s.s. *Mesaba*, of the Atlantic Transport Line, on which ship he remained for two trips. His appointment to the *San Melito* dates from April, 1914, so that by this time he is well acquainted with the ship on which he had such an exciting experience. On behalf of the readers of this magazine we tender him our hearty congratulations upon his fortunate escape.

* * * * * *

S.S. " EL ARGENTINO."

This ship, another victim of the German submarine campaign, was sunk recently, but the operator, Mr. John Tyler, was lucky enough to escape unhurt. Mr. Tyler, whose home is at Forest Gate, is 20 years old. His preliminary wireless training was received at the East London Telegraph Training College, and from this college he proceeded to the Marconi Company's school in the Strand. Upon appointment to the staff he sailed on the s.s. *Tuscania*, transferring later to the s.s. *Pomeranian*, and thence to the s.s. *Mississippi*, *Missouri*, and *El Argentino*. Mr. Tyler was so little affected by the disaster that he has been able to take duties upon another ship, and is now at sea again.

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The Special Problems of Aircraft Wireless—VIII

By H. M. DOWSETT, M.I.E.E.

INSULATION ON AIRCRAFT.

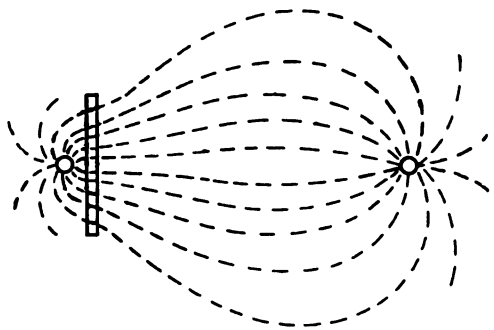

FIG. 4.

section between which there exists a certain potential difference. The conditions at the surface of each wire being the same, they will tend to brush at the same P.D. above space. But suppose a sheet of ebonite is placed between and close against one of them (Fig. 4), then the intensity of

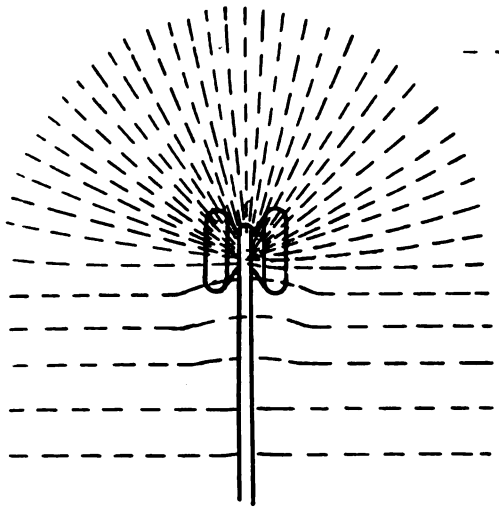

FIG. 6.

IT is not only the neighbourhood of a conductor carrying H.T. current which may create brushing on a thin insulated wire, but the neighbourhood of an insulator under certain conditions may lead to the same result.

Take the case of two wires of equal

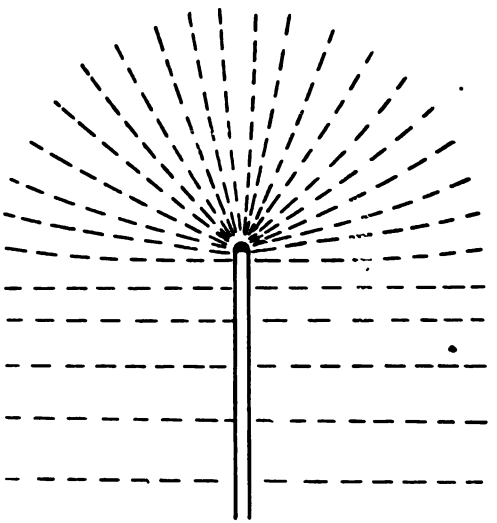

FIG. 5.

the electric field through the ebonite owing to its higher dielectric constant, will be greater than through the same space when filled with air, and, owing to its closeness to the conductor, almost the same intensity of field will exist on the surface of the near conductor as in the ebonite itself. Then, as the brush discharge starts on a given size of wire always at the same intensity of field, the critical voltage on the wire near the ebonite will be much lower than

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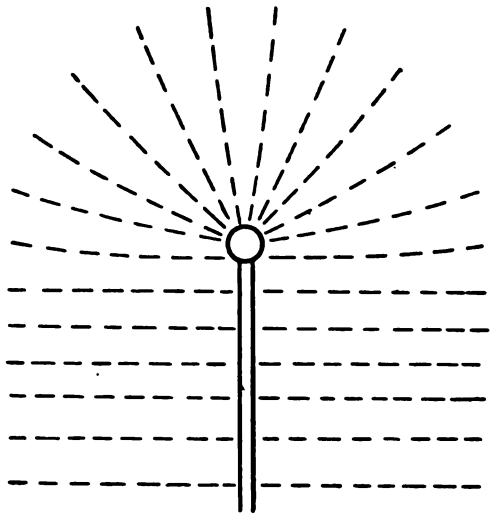

FIG. 7.

on the wire farthest away. If, for instance, the dielectric constant of the ebonite is 2·5 and the critical voltage on the far wire is 7,500 volts, on the near wire it will be about 3,000 volts. Thus, a good insulator used in a faulty manner, or an insulator which is badly designed, may precipitate a danger it was intended to remove.

We now have the reason for the failure of the porcelain insulators used to support the wires in the Alexanderson tests * ; the electric stress—which is always strongest at the end of a wire—was made more intense by the use of insulators having a higher dielectric constant than air, so that the energy used up by the brush discharge on their surfaces and by the dielectric resistance or hysteresis of the porcelain material itself, was quite sufficient to break them down. The following diagrams may help to give a clearer idea of the connection between design of insulator and the electric stress.

Fig. 5 shows the intensity of the electric field on a wire to be greatest at the end; Fig. 6 the increase in intensity due to the use of a porcelain suspension insulator; Fig. 7 the reduced intensity at the end of a wire if it terminates in a knob; Fig. 8 the similar result which follows if a metal cap, plate, or shed is used; Fig. 9 the influence on the stress affecting a porcelain insulator supported by cotton or other insulating line of a metal shed fitted to the end of the wire. Fig. 10 indicates the stress acting on a porcelain insulator supported by wire, metal sheds being used above and below the insulator to decrease the stress and also to protect it against arcover. Fig. 11 shows two parallel metal plates in air, and the effect of inserting an insulator of high dielectric constant between them and transverse to the field. The field is more concentrated on the surface of the insulator, and this encourages a brush discharge and sparking round the edge of the insulator. In Fig. 12 the insulator being inserted parallel to the field does not encourage brushing.

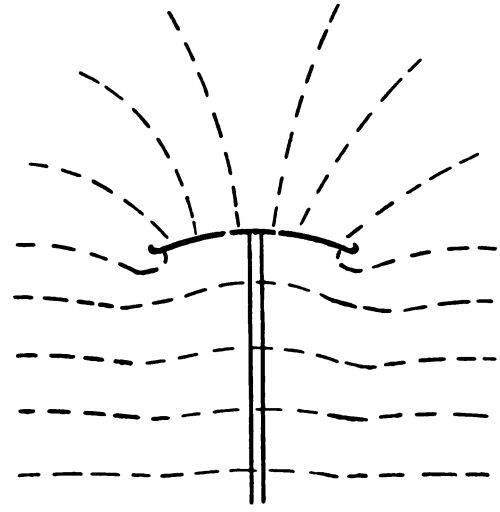

FIG. 8.

* WIRELESS WORLD, July, 1916, p. 300.

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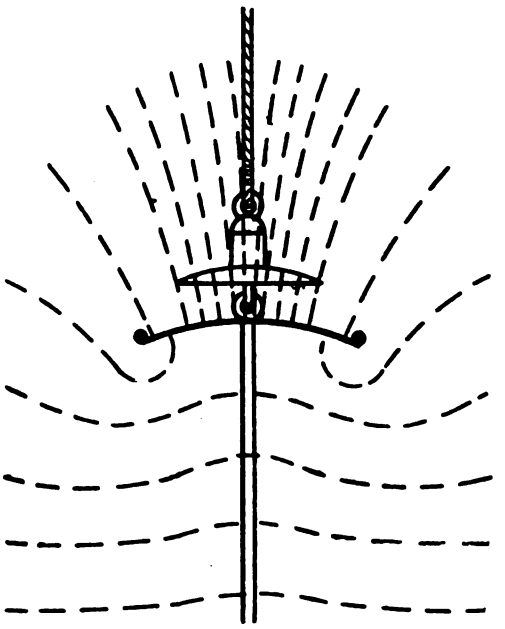

FIG. 9.

Partition insulators can be discussed from a similar standpoint. Fig. 13 shows the field in air between a rod, *R*, and a metal plate, *P*, the rod being fitted through a clearance hole in the plate; Fig. 14, the distorted field which results when the hole is bushed with a parallel insulating sleeve having a high dielectric constant. If the sharp edge of the hole in Fig. 13 is fitted with a spun metal ring (Fig. 15) the stress is considerably reduced. Fig. 16 shows a form of insulating bushing fitted to the metal ring and shaped so that its surface in air is parallel to the electric field, in order that—as in Fig. 12—it shall not increase the tendency to brush. If such an insulator, however, were used in a high frequency circuit and on high tension, its capacity might lead to appreciable loss, and besides would encourage surface sparking; for, whereas the sparking voltage between two conductors in air has almost a straight line relation with the distance, the *surface* or *flash-over* voltage on an insulator having a high dielectric constant has more nearly a cubic and sometimes a fourth-power relation with the distance.*

A rough design for a partition insulator constructed on the model of Fig. 16, but with the capacity reduced as much as possible, is shown in Fig. 17, where *M* is a metal ring, *P* the insulator shell, *C* the insulator cap, and *L* metal lock nuts. Obviously it is a good point if the insulating material used has a low dielectric constant, *provided always that this is not accompanied by higher dielectric hysteresis and low dielectric strength*, which is very often the case. The lower the dielectric constant, the less will the insulator distort the

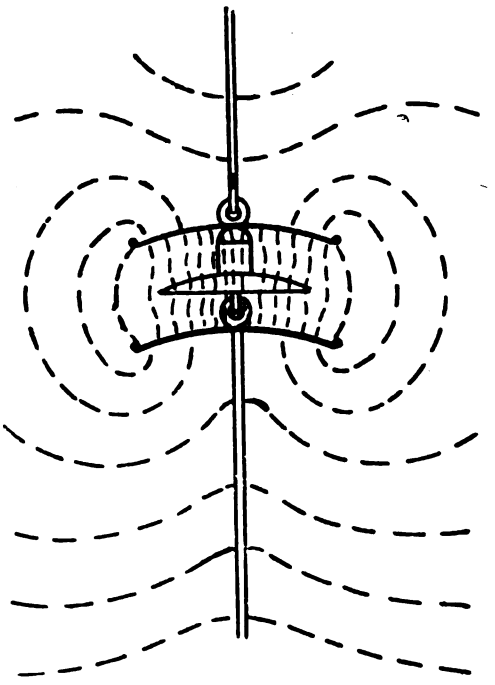

FIG. 10.

* Lustgarten, *Journal Institution of Electrical Engineers*, Vol. 49, No. 214, p. 276.

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field, and the less particular one need be therefore as to the shape of the insulator. Fig. 18 shows the modification in the shell which should accompany the use of metal sheds *S*, the outline curve of the insulator being made to agree with the curvature of the strain lines in the electric field between the conductors as before. Metal sheds limit the voltage which can be applied to an insulator, and thus determine what its minimum dielectric strength should be.

Strain insulators, such as are shown in Fig. 19, are often fitted with

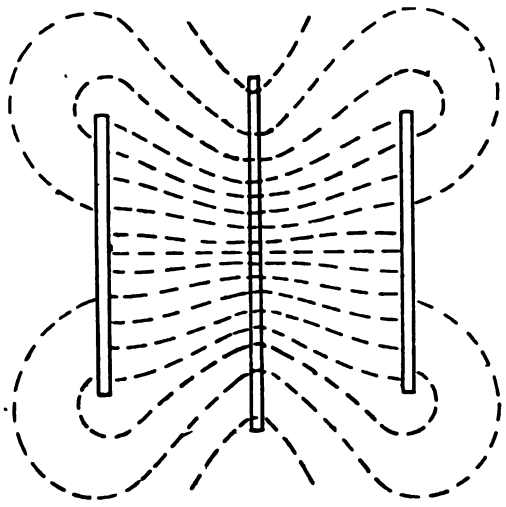

FIG. 11.

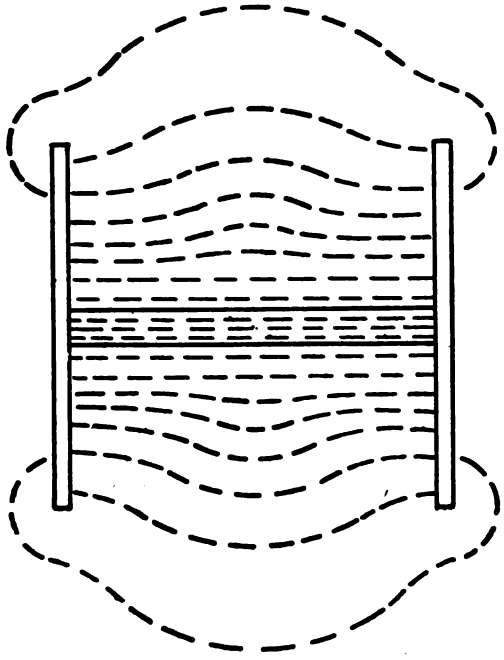

FIG. 12.

wire strops or loops. Strong brushing may result in the grooves or holes in or through which the wire is laid. This brushing may be considerably reduced even if it is not entirely stopped by lining the grooves or holes with metal foil.

The Conditions Necessary to Ignite an Explosive Gas.

A study of the fire risks to which aircraft are liable would be incomplete without some reference to the conditions necessary to ignite an explosive gas; for it has been pointed out that the glow discharge and moderate brushing will not necessarily cause ignition, and even strong brushing induced on a thin wire may fail to do this. The subject has received careful attention during the last few years,

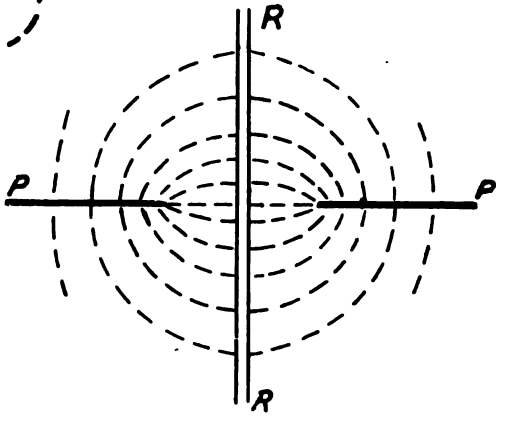

FIG. 13.

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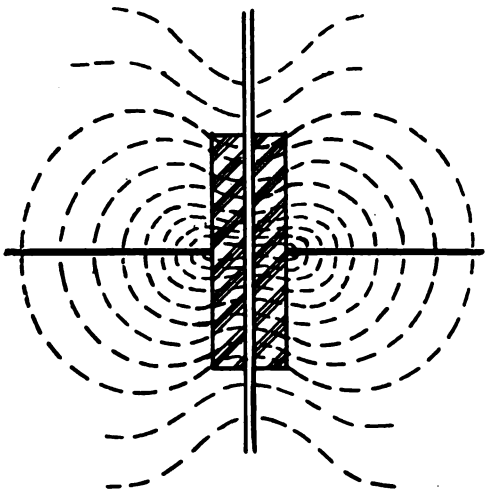

FIG. 14.

the one is not a measure of the other, although there may be a more or less regular relation between them when certain physical conditions are kept constant. Ignition seems to depend on the ionisation caused by the spark. During the interval of sparking the ionisation may be rapidly dissipated or neutralised. If the neutralising action

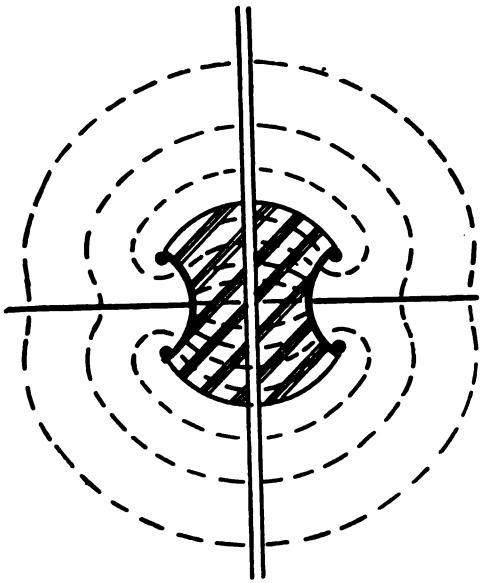

FIG. 16.

mainly in connection with the safe use of electric bells and signalling systems in coal mines.

In an able paper J. D. Morgan * points out "that it is necessary to distinguish between the energy which produces a spark and that quality of the spark termed by him 'incendivity,' which enables the spark to cause ignition; and that the magnitude of

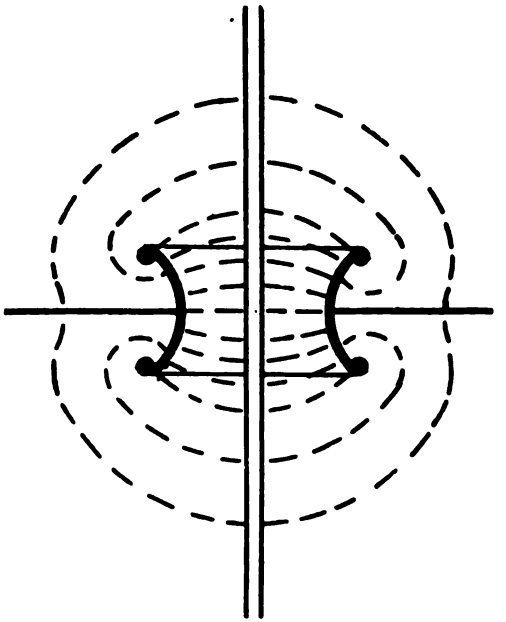

FIG. 15.

predominates there is no ignition of a gas mixture. If there is little or no neutralising action ignition occurs immediately. Between these two limits there are a variety of intermediate conditions."

To produce ignition the temperature of the igniting means must be above a certain definite value, but if the temperature is not accompanied by a sufficient quantity of heat ignition will not occur. The temperature of

* *Journal Institution of Electrical Engineers*, January 1916, p. 200.

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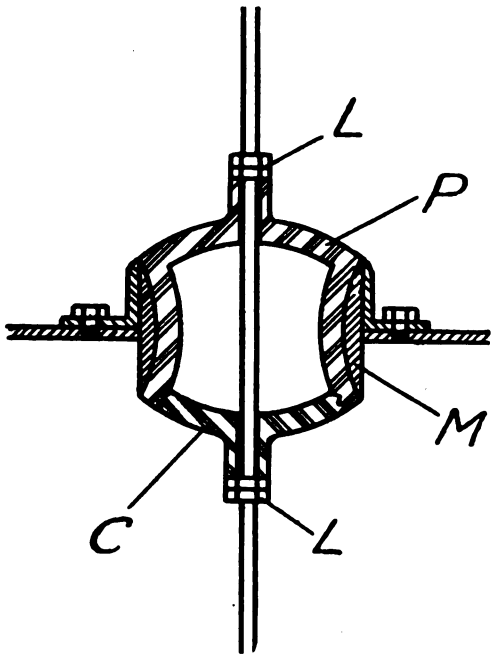

FIG. 17.

continuous current over the disc of a charged electroscope, the temperature at which it ignites an explosive gas is identical with that at which it steadily discharges the electroscope, and it has even been experimentally proved "possible to ignite a cold explosive mixture by the incidence of X rays on a platinum surface in it." *

The outstanding conclusion is that some small electric sparks may be well above the ignition temperature of a highly inflammable gas, yet they will not ignite it. Again, the amount of heat energy required depends on the way it is produced. Thus a spark from a direct current will ignite a gas easier than a spark from an alternating current. And, further, it has been found that if an iron wire is heated by

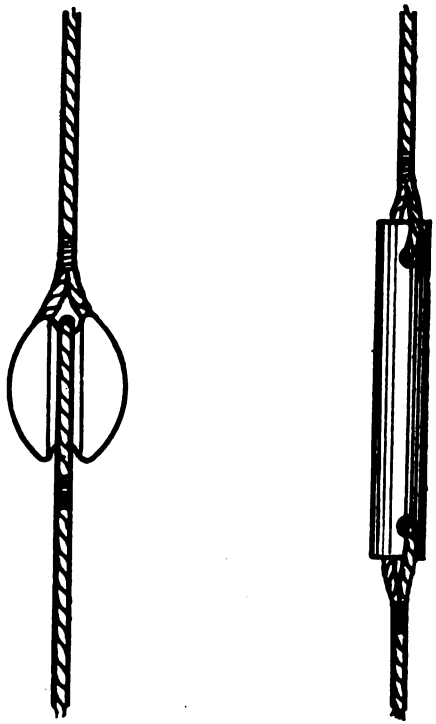

FIG. 19.

ignition depends primarily not on temperature, nor on heat, but on ionisation. This is most important. Thus a small wire may brush and produce small ionisation and be safe, but the least amount of brushing on a wire of large section produces sufficient ionisation to make it unsafe. Also it makes one

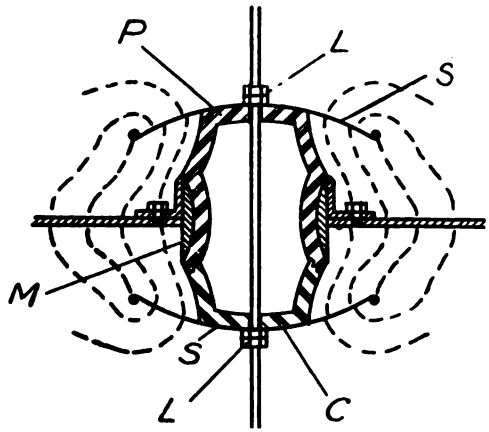

FIG 18.

* J. R. Thomson, quoted by W. H. Thornton, "The Electric Ignition of Gaseous Mixtures," *Proc. Roy. Soy.* A. Vol. 90, p. 272, 1914.

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question the advisability of using metals such as aluminium, zinc, tin, etc., which have strong photo-electric properties for any electrical purpose in a place where an explosive gas may collect, unless they are painted or covered with some material which will protect them from the action of ultra-violet light.

THE RISK OF FIRE FROM THE TRANSMITTING PLANT.

Finally one may refer briefly to the fire risks introduced by the transmitting plant in the aircraft car, which are necessarily less than those due to the engine exhaust and are equally capable of being kept quite under control.

Two principles require to be kept in view :

(1) To ventilate amply all places where an explosive gas can collect ;

(2) To prevent explosive gas coming in contact with sparking apparatus, by enclosing or screening the apparatus, or those parts of it where sparking occurs, from general communication with the surrounding atmosphere.

By " ventilation " is not meant a rush of air which drives the explosive gas into corners where it can eddy with the gas and increase the tendency of the mixture to take fire—as far as practicable there should be no such corners, and certainly no misdirected draught.

Discharger sparks in nearly all types of quenched spark sets are already protected ; rotary dischargers are always boxed in ; the transmitting key contacts, also the buzzer contacts, should be enclosed.

The energy in the spark at the key on break is proportional to the energy commuted in the circuit, or to LI^2. If the key contacts are shunted by a condenser which takes up this energy, the potential at the contacts is reduced, and the spark is, therefore, also reduced ; or, alternatively, the spark can be weakened by means of a non-inductive shunt resistance to the manipulating key, but even the smallest spark remaining should be suspect if it remains unscreened.

An Appreciation

THE gist of a large number of appreciative letters has been crystallised by our Irresponsible Expert as follows :—

I love this Wireless Magazine, it makes me feel so frightfully keen. It tells me things I ought to know and places where it's nice to go. And as beside the babbling brook I read it with enraptured look, absorbing mental nourishment, and getting value every cent, I clean forget my heart is sore and read of " Wireless and the War," or let my fancy wander free o'er " Maritime Telegraphy." When evening drives me in the cottage to read the charming works of Nottage, I gaze into the western sky and think of Dowsett's Aircraft high. Oh, yes, I am an ardent lover of every word within the cover, so now away to peaceful slumber and dreams about the coming number.

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Foreign Notes

NEWFOUNDLAND.

THE free entry of material for installing wireless telegraphy on board ships engaged in the trade and fisheries of Newfoundland was among the proposals made by the Minister of Finance and Customs in his Budget speech of April 18th. The Act embodying this proposal was passed on May 4th.

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UNITED STATES.

The Bureau of Navigation, Department of Commerce, has issued the 1915 edition of *Radio Stations of the United States*. This list shows that there are now 5,073 wireless stations in the United States, an increase of 1,139 since 1914. They are classified as follows: Government and commercial land stations, 224; Government and commercial ship stations, 895; special land stations, 118; general and restricted amateur stations, 3,836.

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To test the efficiency of its portable wireless telegraph instruments and to conduct experiments with its wireless field telephones, the headquarters detail of the Second Battalion Field Artillery, Illinois National Guard, recently went on a two-day hike from Chicago to Willow Springs and back. The detail consisted of twenty-eight men, and included two wagons to carry instruments, and the wagons of the commissary department.

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The lists of United States electrical exports for the month of February last are just to hand. The value of telegraph instruments, including wireless, was $2,542, as against $5,589 for the corresponding month of last year.

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According to word from Louisville, Kentucky, the Harlan Coal Mining Co. and Lick Branch Coal Co. are preparing plans for a wireless telegraph service between the several coal-mines in Harlan County, Kentucky, and the main offices in Louisville. The sending apparatus will be located in the Black Mountains, Harlan County, where the Cumberland range reaches its highest elevation in Kentucky. The receiving end, it is stated, will be on the Starks building, Louisville. The distance on an air line is about two hundred miles, and by rail nearly three hundred miles.

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According to our contemporary, *The Electrical Experimenter*, a Bellini Tosi Direction Finder has been installed at the Naval Radio Station at North Truro, Cape Cod. With it the bearings of a ship from the station can be ascertained by the wireless waves, and the direction can be found, thus affording a new aid to navigators in determining their position. In tests the direction finder has been found correct within about two degrees. All merchant ships fitted with wireless apparatus are requested by the Government to aid in the experiments whenever within range of the station, by requesting their bearings from the station, and stating how such bearings compare with the ship's observation.

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We learn that a wireless telegraph plant is being installed at the Police Headquarters in New York, as part of the great scheme for "general preparedness" which has recently been initiated. About 20 members of the Home Defence League (which has been organized to take the place of policemen called away for riot or other duty) have wireless apparatus on the roofs of the buildings in which they reside; they will, therefore, be in touch at once with headquarters in any emergency. The Police Commissioner also intends to make arrangements whereby the police will be in wireless communication with the harbour and coast defences, and even with vessels of the Navy at sea.

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In order to have a practical test of the nation's preparedness for communication in time of war, a telephonic, telegraphic and radio demonstration was arranged by which the Navy Department at Washington was put into instantaneous touch with every naval station on the Atlantic and Pacific coasts, as well as with the battleship *New Hampshire* at sea. During a period of 40 hours the Navy Department was conducted on a simulated war basis.

Chiefs of the Navy Department carried on all their business with the important naval stations by telephone, while the Secretary of the Navy, the Naval General Board, the Office of Naval Intelligence, and the Chief of Naval Operations, received at the same time from the *New Hampshire* wireless telephonic reports of her search for imaginary enemies.

The test was arranged at the request of Secretary Daniels.

* * * * * *

President Wilson recently opened the Philadelphia "To-day and To-morrow Civic Exposition" by wireless telegraphy from the White House. This is not the first time the President has availed himself of wireless telegraphy as a means of fulfilling duties when he is unable to be present in person.

Wireless Telephony "with a Vengeance"

ACCORDING to an American scientific journal, it will not be long before England and America will be able to converse with one another by means of the wireless telephone. There are certain individuals to-day who cling to the conviction that the telephone was simply the invention of a man who had a grudge against humanity. What will they now say of the wireless telephone? There is this much to say. It will be much better than those cheap wire telephones, the wires of which are so apt to snap if you don't pay up your subscriptions. With the wireless telephone it may be that you will receive a second demand note for payment, but there will be no man with a pair of wire-cutters in his pocket to bring the third and last demand note and cut you off if you do not pay at once. It is going to be very exciting when we get those wireless telephones in full working order. Just imagine yourself stepping into a call box in Victoria Street and asking for "45678, Broadway, NewYork City." While the young lady is waking up New York you just sit down and read a few chapters from your Shakespeare or Bacon—according to which school you belong. But it will test your temper when the young lady tells you that you are through, and will you please drop three hundred and sixty-five pennies in the slot and "turn the handle after each, please."

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Instructional Article

NEW SERIES (No. 12).

The following series, of which the article below forms the twelfth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Rate of Increase.

84. In Fig. 75 we have an irregular but smooth curve, AB. If this represents section through a hill we know, from merely looking at the curve, that if we walked from A to B we should start off downhill from A, then climb the hillside, and, finally, walk a short distance downhill again to reach B.

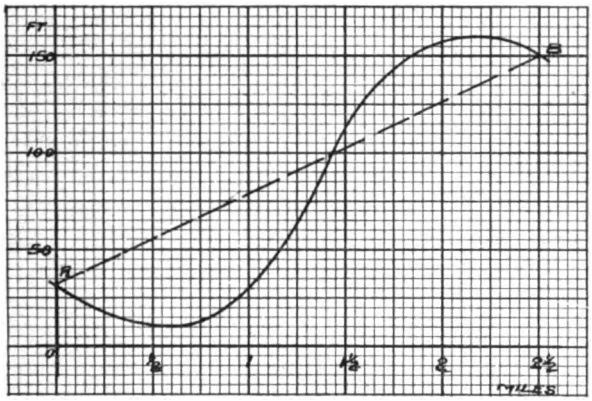

FIG. 75.

Now, to the scale of this diagram, the *horizontal* distance between A and B is $2\frac{1}{2}$ miles, and the *vertical* distance—or difference in height—is $(150-33)=117$ ft. Thus, in traversing $2\frac{1}{2}$ miles *along* we move 117 ft. *up*, and so the *average rate* at which we rise is $\frac{117 \text{ ft.}}{2\frac{1}{2} \text{ miles}} = 46\frac{3}{4}$ ft. per mile. This can be expressed as the average *rate of increase of height with respect to distance*, or the *rate at which height varies as distance varies.*

This slope is shown geometrically by the straight line AB.

But obviously most of the hillside we have to climb is much steeper than this; parts near the summit and near the valley bottom are less steep; and other parts again are actually downhill. Thus the average slope, obtained as above, is no guide whatever to the slope at intermediate points.

85. In Fig. 76 we have another curve, and we will set to work to find the slope of the curve at a certain

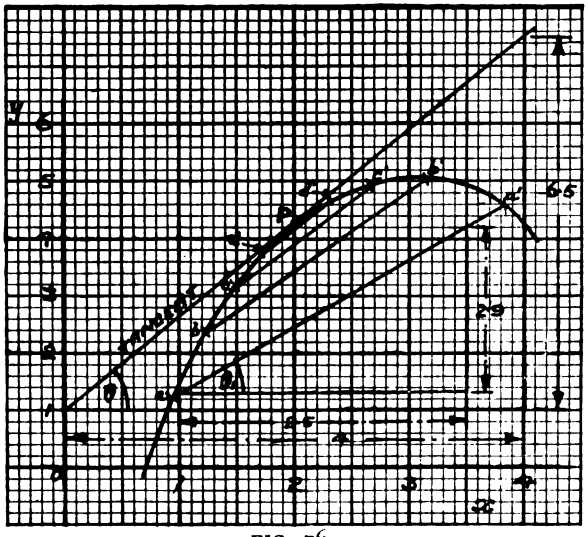

FIG. 76.

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point, *P*. By this we do not mean the average slope over a part of the curve which includes *P*, but the actual slope *at* the point *P* itself.

With P as centre draw a few circles of differing radii, thus marking off various pairs of points $a\ a^1$, $b\ b^1$, . . . on the curve, equidistant from and on opposite sides of *P*.

Now the straight line $a\ a^1$ gives us the average slope between *a* and a^1, $b\ b^1$ gives us the average between *b* and b^1, and so on.

From a consideration of these lines, $a\ a^1$, $b\ b^1$, $c\ c^1$, and $d\ d^1$ we see that the nearer to *P* we take the two points, the more accurately does the line joining the points show the true slope at *P*. Thus to get an absolutely accurate representation of the slope at P, we must take the two points at no distance whatever from *P*, or, in other words, we must draw a straight line which touches the curve only at the point *P*. Thus we must draw the *tangent to the curve at the point P*, and the slope of this tangent will be the true slope of the curve at that point.

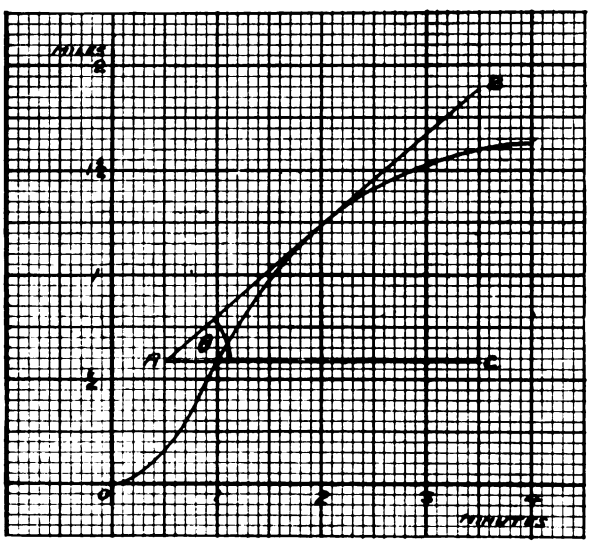

FIG. 77.

Now the slope of this tangent is given, as we know already, by tan θ, where θ is the angle the tangent line makes with the horizontal. In this particular case

$$\tan\theta = \frac{6{\cdot}5}{4} = 1{\cdot}625.$$

The *average* slope between *a* and a^1 is $\frac{2{\cdot}9}{2{\cdot}5} = 1{\cdot}16$, quite a different value.

86. Let us now consider, rather more fully, exactly what we get when we go to the trouble of drawing this tangent and measuring its slope.

In Fig. 77 we have a curve which gives us the distances travelled by a train at various times after starting its run. To get the slope of this curve at 2 minutes from the start we draw a tangent *AB* as shown, complete the triangle *ABC*, and measure off *BC* and *AC*.

Then the slope of the curve $= \frac{BC}{AC} = \tan\theta$.

But $BC = 1{\cdot}885 - 0{\cdot}58$
$= 1{\cdot}305$ miles,
and $AC = 3$ mins.

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Therefore $\tan\theta = \frac{1{\cdot}305 \text{ miles}}{3 \text{ minutes}} = 0{\cdot}435$ *miles per minute* or 26·1 *miles per hour.* This value is a *velocity.*

Thus the slope of this distance-time curve at any point gives us the velocity of the train at that particular time. Velocity is, of course, the rate at which distance changes as time changes, or the *rate of change* of distance.

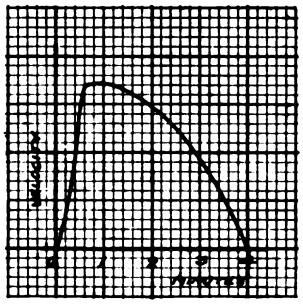

FIG. 78.

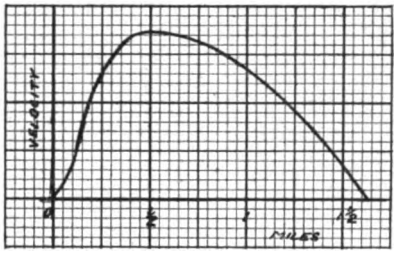

FIG. 79.

If now we measure the velocity in this way at a number of points along the curve, we can plot two further curves—we can plot either a velocity-time curve (Fig. 78) or a velocity-distance curve (Fig. 79). [These two curves are not drawn to scale.]

Going a step farther, it will be easily understood that we can now draw tangents to the curve of Fig. 78, the slope of each of which will give us the value of the *rate of change of velocity* or *acceleration.* Another curve, such as Fig. 80, can now be drawn, and if we care, we can draw tangents to this curve so as to find the *rate of change of acceleration,* and so on indefinitely.

Notice that the acceleration is zero at three points :

(*a*) Just before starting ;

(*b*) About one minute after starting, when the speed has reached a constant value, and

(*c*) When the train has stopped at the end of its run.

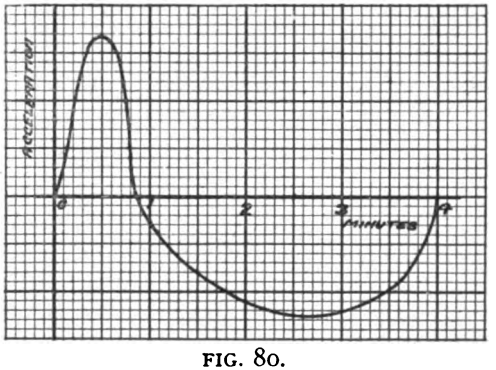

FIG. 80.

87. In Fig. 81 we have part of the curve of $y=x^2$. From the point (1, 1) is drawn the horizontal line AB, and perpendiculars C_1D_1, C_2D_2, etc., are drawn from the curve on to AB at the successive whole-number values of x —as shown.

The average slope of the curve between A and $C_4 = \frac{C_4D_4}{AD_4}$

The average slope of the curve between A and $C_3 = \frac{C_3D_3}{AD_3}$,

and so on.

Now it is quite obvious from this that the smaller we make the interval AC, the nearer the resulting ratio becomes to the value of the slope at A, and so we should expect that if we were to take the *smallest imaginable* distance AC we should

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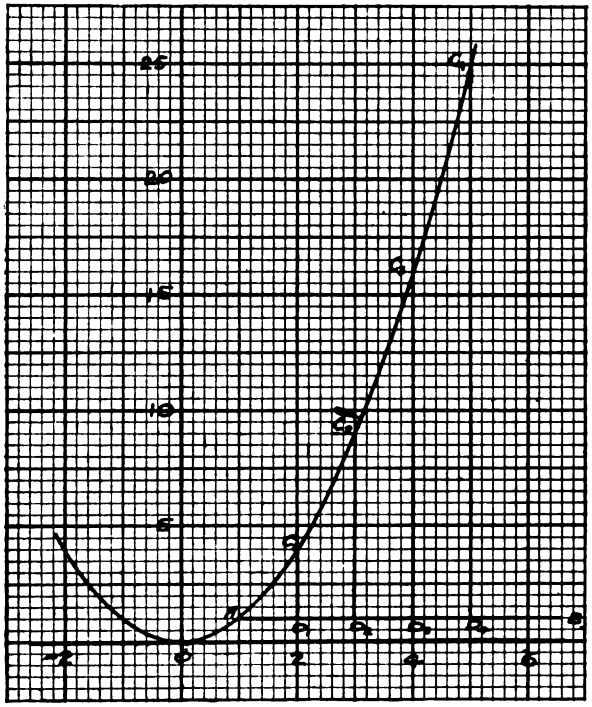

FIG. 81.

obtain a ratio which would be the true value of the slope at A.

The trouble is that when we get to dealing with such exceedingly minute quantities we can no longer carry out the operations of drawing a part of the curve and measuring off the lengths. We can, however, *if we know the law of the curve, calculate* this rate of increase. In other words, leaving out the now unnecessary curve, we can calculate the rate of change of one quantity with respect to another quantity if only we know for certain the law connecting the two quantities.

Returning for a moment to Fig. 81 we see that, reckoning for our initial point A, the numerator of our fraction, say C_1D_1, is a *small increase of* y, and the denominator AD_1, the *corresponding small increase of* x. We now have to consider the ratio between two similar corresponding increases of y and x, but of very much smaller value. Let us call these two extremely small increases δy and δx, so that we now have to find the value of $\frac{\delta y}{\delta y}$.

[Note that δy is *not* δ multiplied by y, but is simply a short and convenient way of writing an infinitesimally small bit of y.]

Drawn to a very much increased scale we now have the conditions shown in Fig. 82.

It must be carefully borne in mind that, though both δy and δx are extremely small in themselves, yet the new values $(y+\delta y)$ and $(x+\delta x)$ still conform to the law $y=x^2$, and also the ratio $\frac{\delta y}{\delta x}$ may be of any value—positive or negative. A is the point (x, y) and C is the point $[(x+\delta x), (y=\delta y)]$.

Now at A we have $y=x^2$

and at C we have $(y+\delta y)=(x+\delta x)^2$

$$=x^2+2x.\delta x+(\delta x)^2$$

Subtract the original equation $y=x^2$

and we have left $\underline{\delta y=2x.\delta x+(\delta x)^2.}$

[Note that at C we do *not* write $(y+\delta y)=x^2+\delta x$.]

The next step is extremely important. δx is an infinitesimally small quantity, and so $(\delta x)^2$, being $(\delta x \times \delta x)$ or an infinitesimally small quantity *of* an infinitesi-

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mally small quantity *is negligible in value compared with the other quantities in the equation.*

For instance, $\frac{1}{100}$th of £1,000 is £10, but $(\frac{1}{100})^2$ of £1,000 $= \frac{£1,000}{100 \times 100}$ $= £\frac{1}{10} = 2$s. only.

$\frac{1}{1000}$th of £1,000 is £1, but $(\frac{1}{1000})^2$ of £1,000 $= \frac{£1,000}{1000 \times 1000} = £\frac{1}{1000} = \frac{1}{4}$d. (approximately).

The second powers of δy and δx can, therefore, be neglected, and instead of $\delta y = 2x.\delta x + (\delta x)^2$ we can write $\delta y = 2x.\delta x$.

From this we get $\frac{\delta y}{\delta x} = 2x$, or the rate of change of y with regard to x is equal to $2x$.

When δy and δx are reduced to the absolute minimum possible, we write $\frac{dy}{dx} = 2x$, and the ratio $\frac{dy}{dx}$ is called the *Differential Coefficient* of y with regard to x.

[Here, again, dy and dx are *not* $(d \times y)$ and $(d \times x)$.]

Knowing, in this way, that the rate of change of y is equal to $2x$, we see immediately that if

$x = 1$, the rate of increase $= 2$,
$x = 5$,, ,, $= 10$,
$x = 0$,, ,, $= 0$,
$x = -10$,, ,, $= -20$,
$x = \pi$,, ,, $= 2\pi$, and so on.

In the foregoing manner we can calculate the relative rates of increase of any quantities connected by known laws.

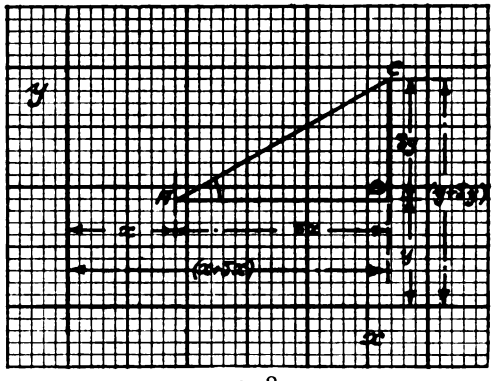

FIG. 82.

Examples.

(i.) $y = 6x^5$

$y + \delta y = 6(x + \delta x)^5$

$= 6\{x^5 + 5x^4.\delta x +$ terms containing higher powers of δx which can therefore be omitted$\}$.

$= 6x^5 + 30x^4\ \delta x.$

Subtract $y = 6x^5$

and we have left $\delta y = 30x^4\ \delta x.$

Therefore, $\frac{\delta y}{\delta x} = 30x^4 = \frac{dy}{dx}.$

(ii.) A body falling freely from rest, falls so that $s = \frac{1}{2}gt^2$

where s = height fallen through (in feet)

g = acceleration due to gravity (a constant—32·2 ft. per sec. per sec.)

and t = time taken in falling (in seconds).

Find expressions for

(*a*) The velocity, and

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(*b*) The acceleration at any time.

$$s=\tfrac{1}{2}gt^2=\tfrac{1}{2}\times 32{\cdot}2\ t^2$$
$$=16{\cdot}1\ t^2$$

Now velocity $=v=\dfrac{ds}{dt}$

and acceleration $=f=\dfrac{dv}{dt}$.

(*a*) Starting with $s=16{\cdot}1\ t^2$

we have $s+\delta s=16{\cdot}1\ (t+\delta t)^2$

$$=16{\cdot}1\ [t^2+2t.\delta t+(\delta t)^2]$$

or $s+\delta s=16{\cdot}1\ t^2+32{\cdot}2\ t\delta t.$

Subtract $s=16{\cdot}1\ t^2$

and we have left $\delta s=32{\cdot}2\ t.\delta t.$

Thus, $\dfrac{\delta s}{\delta t}=32{\cdot}2\ t$

or $v=\dfrac{ds}{dt}=32{\cdot}2\ t$ (ft. per sec.).

(*b*) Starting with $v=32{\cdot}2\ t$

we have $v+\delta v=32{\cdot}2\ (t+\delta t)$

$$=32{\cdot}2\ t+32{\cdot}2\ \delta t$$

Subtracting $v=32{\cdot}2\ t$

we have left $\delta v=32{\cdot}2\ \delta t.$

Therefore, $\dfrac{\delta v}{\delta t}=32{\cdot}2,$

or $f=\dfrac{dv}{dt}=32{\cdot}2$ (*ft. per sec. per sec.*)—and is independent of time.

From these results we see that—

the velocity after 10 seconds $=32{\cdot}2\times 10$

$$=320\ \textit{ft. per sec.}$$

but the acceleration after 10 seconds $=32{\cdot}2\ \textit{ft. per sec. per sec.}$

(*To be continued.*)

The Institute of Radio Engineers

AT the meeting of the Institute of Radio Engineers held on Wednesday, June 7th, in the Engineering Societies Building, New York, a paper on "Arc Oscillations in Coupled Circuits" was read by Professor Hidetsugu Yagi, of the College of Engineering at Sendai, Japan. The efficient transfer of energy from the primary to the secondary and the production of overtones were fully considered. The paper was illustrated by many interesting experimentally determined curves.

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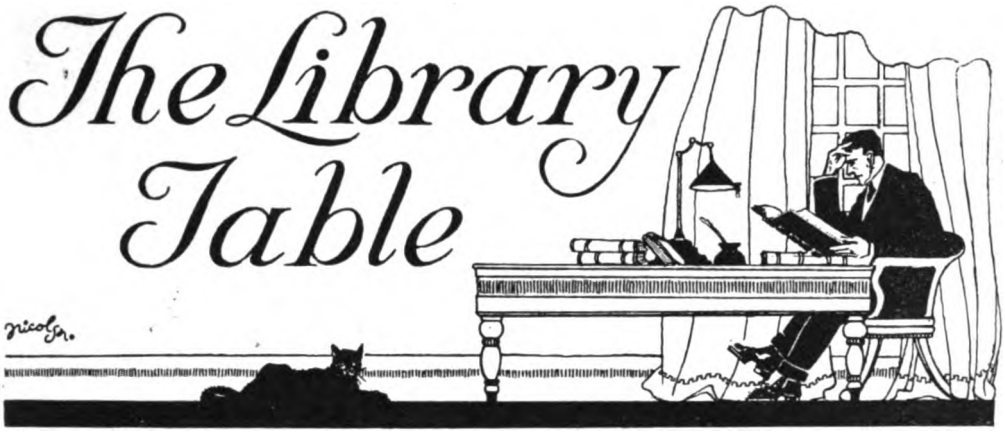

" THE BORDERER." By Harold Bindloss. London : Ward, Lock & Co. 1916. 6s.

To us there always appears a great sameness in the war novels which we have from time to time perused. The book under review forms no exception. The general outline is that Andrew Johnstone, the principal character, is in Canada at the time of the outbreak of war, and receives a summons to return home. His chum Whitney accompanies him, and together they search the southern coast of Scotland for illicit wireless apparatus, and the sources of supply to German submarines. In the course of his narrative Mr. Bindloss refers to Trinity House in connection with the survey of waters around our coast. We believe that he is incorrect here, this forming part of the duties of the Hydrographic Department of the Navy. The book may perhaps find a certain amount of favour, but the interposition of many points irrelevant to the story renders it disconnected. We must say, however, that Mr. Bindloss's composition is pleasing and fluent.

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" A FIRST COURSE IN ENGINEERING SCIENCE." By P. J. Haler and A. H. Stuart. London : University Tutorial Press, Ltd. 2s. 6d.

We learn from the Preface that this little book embodies both the material and the suggested treatment of that material laid down in a recent circular issued by the Board of Education under the title " Memorandum on the Teaching of Engineering in Evening Technical Schools," assigned to the First Year of the Major Course of " Engineering Science." The book also covers the ground required for the examination in Mechanical Engineering, Division 1, Grade 1, of the City and Guilds of London Institute.

The authors have certainly produced a book clearly written in an interesting manner and copiously illustrated. We are glad to see the inclusion of numerous examples and exercises and a useful appendix, giving tables of useful constants, densities of metals, strengths of materials, etc. Answers to the exercises are given in the final pages. Altogether this is an excellent little book, well suited for the purpose for which it is designed.

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"THE EDUCATION OF P. J. DAVENANT." By Lord Frederick Hamilton. London: Eveleigh Nash Co. 1916. 6s. net.

There are many more melodramatic institutions, but none more deserving than that which, under the patronage of the Marchioness of Lansdowne, is raising the "Officers' Families Fund." Lord Frederick Hamilton has created a brand-new hero for the purpose of coaxing contributions from the pockets of book buyers, and every purchaser of the volume under review will—thanks to the author's generosity—add his quota to the fund. This hero is a boy in his teens gifted with much of the astuteness of Sherlock Holmes, but possessed of a *naïveté* all his own. His name is P. J. Davenant, and he now makes his third bow before the world.

It is a quaint conceit to open the volume with three chapters, in our opinion the best in the book, and then recommend "those to whom the things of the country make no appeal" to skip them! The author has perhaps found some criticism levelled at young Davenant in his previous appearances on account of his super-boyish acumen and success. Accordingly, in this reincarnation, he opens his "War-time Detection" yarns with a failure; and throughout maintains a considerably sobered tone of colour. The pursuit (and capture) of the German Secret Wireless Spies constitutes a well-thought-out and interesting adventure of the detective variety, and the incidental voyage of H.B.M. Destroyer *Gannet* is described in a way which appears to indicate that the author writes from personal experience.

The literary workmanship of the *Education of P. J. Davenant* displays a marked improvement on that of the previous volumes, and the comico-pathetic sketches of wounded soldiers in hospital, though still suffering a little from the absence of that "restraint" which only practice can give, furnish excellent sentimental reading of the more "obvious" kind. Just one word about "Ted," the gipsy stable-boy. We should like to find, when next we meet him, that his marvellous attainments are a little less pronounced and that his character is outlined with less harsh contrasts of light and shade.

* * * * * *

"ATMOSPHERIC CIRCULATION AND RADIATION." By Frank H. Bigelow, M.A., L.H.D. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. 21s. net.

This volume, the full title of which is *A Meteorological Treatise on the Circulation and Radiation in the Atmospheres of the Earth and of the Sun*, is scarcely of the type of literature which appeals to the "man in the street." On the other hand, it is one of those treatises which, whilst making a strictly limited appeal, is nevertheless of great value to the scientific world.

The author, who was for some years Professor of Meteorology in the United States Weather Bureau and is now attached to the Argentine Meteorological Office, is of course an authority on the subject, and we have no doubt that the volume will be welcomed wherever meteorology is studied.

Although the scientific study of the great problems relating to the weather may be said to date from about the year 1870, an enormous mass of observations has been made, and it is upon the careful study of these observations that this volume has been based. Numerous tables and diagrams are interspersed throughout the book, which is exceedingly well produced.

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"QUESTIONS AND SOLUTIONS IN TELEGRAPHY AND TELEPHONY—FINAL EXAMINATIONS." By H. P. Few. London: S. Rentell & Co., Ltd. 1s. 6d. net.

This little book, which is a companion volume to the Author's *Questions and Solutions in Telegraphy and Telephony Grade One Examinations* (already reviewed in our columns), needs no introduction to those who are acquainted with the previous book and its excellencies. The book is designed primarily for students undertaking the City and Guild Examinations in Telegraphy and Telephony, but will be found useful by all who study these subjects whether or not they intend entering for these tests. Here and there we find questions on wireless telegraphy which have appeared in various years' examinations.

* * * * * *

"WHITTAKER'S ARITHMETIC OF ELECTRICAL ENGINEERING FOR TECHNICAL STUDENTS AND ENGINEERS." London: Whittaker & Co. 2s. net.

This useful little book, which has now run into three editions, aims at providing students of electrical engineering with numerous practical explanations and examples, so that they may learn to calculate quickly and accurately. The plan adopted in the book is first to give very briefly the fundamental quantitative relationships and laws and then the numerous worked-out typical examples illustrating the principles of the subject, as a guide to the methods of tackling practical problems. In addition there are some 300 carefully graduated examples for the student to work out himself. The book well deserves the success it has already attained.

* * * * * *

"NOZIONI ELEMENTARI DI RADIOTELEGRAFIA." Ufficio Marconi, Rome. Limp cover, 2 lire; cloth boards, 3 lire, postage extra.

Students and all in Italy who are interested in radiotelegraphy will welcome, under the title of *Nozioni Elementari di Radiotelegrafia*, a translation of the famous *Elementary Principles of Wireless Telegraphy*, by R. D. Bangay. The translation, which has been carefully prepared by the Marquis Luigi Solari, whose connection with wireless telegraphy in Italy is well known, does full justice to the well-known handbook, and is splendidly illustrated with diagrams and drawings of apparatus. It is essentially a book for the beginner and presupposes no previous knowledge of magnetism and electricity, so that it can safely be recommended for use in schools where an advanced course in the science of electricity is not provided. Containing no superfluous matter and filled from cover to cover with interesting facts and explanations, it carries the reader to a point where he is able clearly to understand the underlying principles of wireless apparatus and the manipulation of simple installations. Although it is easily comprehensible by the schoolboy and the young student in technical colleges, it is yet by no means unsuitable for the adult student, and will not irritate by the childish explanations which sometimes appear in elementary text-books. Without a doubt the Italian edition will have an extensive sale wherever that language is spoken.

NOTE.—*Any of the above books will be forwarded by return of post upon receipt of remittance covering cost of book and postage, by the Wireless Press, Ltd., Marconi House, Strand, W.C.*

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Personal Notes

It is with great regret that we have to announce the death of Professor Silvanus Phillips Thompson, which occurred at his London residence after an illness of only two days' duration. Professor Thompson was born at York on June 19th, 1851. He attended the Bootham (Friends') School in that city, and the Institute at Pontefract, and graduated at London University in 1869. Devoting himself to physical science, he acted for a time as science master at his old school in York, but gave up that position in order to study in London, where he graduated with high honours as B.Sc. in 1875, proceeding to his doctor's degree in 1878. In the latter year he received the appointment of Professor of Experimental Physics at University College, Bristol, and in 1885 became Professor of Physics in the City and Guilds Technical College, Finsbury, of which he was also Principal. This position he held up to the time of his death. He was an author of no mean repute, and among his well-known works are "Elementary Lessons in Electricity and Magnetism" and "Wireless Telegraphy and Telephony."

* * * * * *

It is our sad duty to record this month the death in action of Lieut. Bernard C. de B. White, who from 1912 until the outbreak of war held the position of Assistant Editor of this magazine. At the commencement of hostilities he obtained a commission as Second Lieutenant in the York and Lancaster Regiment, afterwards transferring to the 1st Tyneside Scottish, 20th Northumberland Fusiliers. It is only recently that he obtained his full lieutenancy. The literary work of Lieut. White will be well known to our readers, for he was the author of numerous signed and unsigned articles and of several poems which appeared in our pages. His death will come as a severe blow to those with whom he worked.

Lieut. White is the second member of the staff of the Wireless Press, Ltd., to be killed in action, the first being Mr. C. F. Warren, whose death occurred in May, 1915.

* * * * * *

A most impressive and pathetic funeral was recently witnessed at Brompton Cemetery, when, in the presence of nearly 2,000 people, the remains were interred, in the family grave, of Mr. Sydney Leonard Leggett, of the Wireless Section, Royal Naval Air Service. The deceased, who was only 21, was killed in a collision at Shoreham whilst motor-cycling. Amongst the many floral tributes was a unique and lovely model of a wireless station, from the family, designed by Mr. Leggett, senior, who is

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a florist; a superb wreath from the officers and men of the wireless section of the R.N.A.S., whilst the young girl who was riding with deceased at the time of the accident, and had a marvellous escape, sent a pretty bunch of flowers.

* * *

LANCE-CORPORAL DE MONCHO

We have received a notification that Mr. L. de Moncho has been promoted to the rank of Lance-Corporal on the field, and also that in the Birthday Honours of June 3rd he was awarded the Military Medal for Bravery and devotion to duty under shell fire at Givenchy and Loos. He is now at Vimy Ridge. We congratulate Mr. de Moncho, who before the war was a member of the Accountants Department of the Marconi Company.

* * * * * *

We have to announce that Wireless Operator Arthur H. Kidd, of H.M.S. *Attentive*, has been invalided out of the service after being four weeks in hospital at Deal.

* * * * * *

Among those mentioned in Sir Douglas Haig's last dispatch for gallant and distinguished service in the field is Sergeant Gilbert Metcalfe, of the Royal Engineers. Sergeant Metcalfe is 28 years of age, and entered the Army in October, 1914. He was attached to the Postal and Telegraph Office at York, and it is in the capacity of telegraphist that he has proved a valued member of his company of Engineers. Since joining the Army he has become proficient as a wireless telegraph operator. We offer him our congratulations.

* * * * * *

We congratulate Second Air Mechanic J. F. Menear, news of whose marriage has just come to hand. Mr. Menear was in the Traffic Department of the Marconi Company, and some time ago enlisted in the Wireless Section of the Royal Flying Corps, being stationed at Farnborough. His marriage took place at St. Mark's Church, Farnborough, on June 7th last. Before he enlisted Mr. Menear was a keen member of the Marconi Athletic Club. We trust that Mr. and Mrs. Menear will have many happy days before them.

* * * * * *

Second Lieut. H. Broadbent, of the Wireless Section 3rd Canadian Division, is well known in wireless circles in the North of England. He took his certificate at the North-Eastern Schools of Wireless Telegraphy, Newcastle-upon-Tyne, and later acted as instructor at the West Hartlepool branch of that institution.

On the outbreak of war Sec. Lieut. Broadbent was Sergeant Instructor of

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Signallers and Telegraphists in the 7th Durham Light Infantry (Territorials), and went out with his battalion to France in the spring of 1915. After the second battle of Ypres he was transferred to the Royal Engineers, and it was during his connection with this latter unit that he won the D.C.M. and was given his commission.

The *London Gazette* describes the grant of the medal in the following terms: "2695 Sergt. H. Broadbent, No. 4 Section, 50th Divisional Signal Co., R.E. (T.F.)—for going out alone and mending breaks in the lines under heavy shell fire. Later, when the main cable was broken in several places, he repaired it, and remained all the afternoon on the spot in a dug-out, going out to repair it again whenever necessary."

The General on the parade ground publicly commended Sec. Lieut. Broadbent for his excellent work. On his appointment to commissioned rank he was posted to the 3rd Canadian Division.

* * * * * *

The engagement has just been announced of Miss Wintringham to Captain Williamson, of the Manchester Regiment, now attached to the Royal Flying Corps. This gentleman was in command at the wireless station at Humberstone for some time and is well known in that neighbourhood. He has been out to the Front and was the recipient of the Military Cross.

SECOND LIEUT. H. BROADBENT.

* * *

We learn with pleasure that Wireless Telegraph Operator (first class) A. Andrews, R.N.R., O.N. 13 W.T.S., has been awarded the Distinguished Service Medal. We congratulate him on behalf of our readers and ourselves.

* * *

The funeral recently took place at Oxbridge Cemetery, Stockton, of Mr. Edwin T. Hall, of the Coastguard Service. The deceased had seen extensive service since 1885, when he joined *H.M.S. Exmouth*. His duties subsequently carried him aboard several of His Majesty's vessels, until 1901, when he joined the Coastguard; two years ago he was removed to a wireless station on the North-East Coast. The members of the staff at the wireless station were largely represented in the cortège and a firing party was also in attendance.

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Company Notices

Marconi International Marine Communication Company, Ltd.

Account of General Meeting

THE 16th Ordinary General Meeting of the Marconi International Marine Communication Company (Ltd.) was held on the 14th June, at the Hotel Cecil, Strand, Mr. Godfrey Charles Isaacs (Managing Director) presiding.

The Secretary (Mr. Henry W. Allen, F.C.I.S.) having read the notice convening the meeting and the report of the Auditors,

The Chairman said: Gentlemen,—Mr. Marconi, having matters of the highest importance to attend to in Italy, wishes me to express again his regret at not being able to preside to-day. With your approval I adopt the usual course of taking the report as read, and I will proceed to deal with the figures in the accounts.

BALANCE-SHEET CHANGES EXPLAINED.

Turning first to the balance-sheet, you will observe that the Debentures show a small reduction of £320, accounted for by purchases to that amount having been made during the year. The creditor balances at the end of 1915 are some £11,000 less than they were at the same time in the preceding year. The item of £10,000 standing to special reserve for war contingencies we are proposing to transfer to general reserve account, having debited all the losses incurred during the year from the submarine warfare to the profit and loss account. As we have informed you in the report, we are also transferring to reserve account the £17,639 14s. 3d. which previously appeared as share premium account, and this sum, together with the £10,000, will amount to £27,639 14s. 3d. carried to the reserve account. Having regard to the item of £219,381 11s. 7d. which stands upon the other side to the credit of licence and rights and shares in associated companies, we think it right to build up year by year a substantial reserve to set off this item. The only other figure calling for any comment on the debit side is that of £8,095 8s. 6d. for excess profits duty. This was the amount payable for 1914, and I feel sure that the whole of our shareholders will be at one with me when I say that it has afforded us the greatest satisfaction in the present circumstances to be able to contribute this amount and to know that the sum payable for the past year will be a more substantial one still.

Turning to the credit side, the item of plant, apparatus, furniture, and stores, which represents for the most part telegraph stations on board ships, shows a net increase of nearly £3,000, notwithstanding the fact that a number of installations were lost during the year, and a substantial sum has been written off in keeping with our custom for depreciation. The increase is, of course, explained by the amount represented by new installations fitted during the year exceeding the sum represented by loss and depreciation. Our available cash resources at bankers and on loan show an increase of some £11,000, which is very satisfactory considering the large expenditure made during the year upon capital account.

GROSS AND NET RECEIPTS INCREASED.

Turning to the profit and loss account, our gross receipts amount to £208,899 14s. 2d., being £33,000 higher than for 1914, and the net profits for the year amount to £63,630, an increase of nearly £8,000 over those of the preceding year. I think we can congratulate ourselves upon this result, especially when we bear in mind, firstly, that our business is necessarily being conducted in very difficult and abnormal circumstances, and, secondly, that the whole of our losses incurred through the submarine warfare have been debited to the profit and loss account.

It will be interesting here to note the regular growth of our gross receipts during recent years: In 1911 they amounted to £64,166; in 1912 to £100,325; in 1913 to £146,325; in 1914 to £175,105; and in 1915 to £208,927.

THE YEAR'S DIVIDEND 12½ PER CENT.

Turning again for a moment to the balance-sheet, the available balance to the credit of profit and loss account at the end of 1914 was £64,855 14s. 11d. Out of this sum we paid dividends of 10 per cent., amounting to £30,608 8s., we placed to reserve for repayment of Debentures £3,500, to special reserve £10,000, for additional Directors' fees £1,000, and excess profits duty £8,095 8s. 6d., which left a balance to be carried forward of £11,971 18s. 5d. This sum, added to the profit and loss account for the year under review, gives us an available balance of £75,602 1s. 1d. We have declared an interim dividend of 5 per cent., which was paid on February 1, absorbing a sum of £15,304 4s., and, subject

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to your confirmation, we propose paying a final dividend of 7½ per cent., making 12½ per cent. for the year, which will require a further £22,956 6s., and, after placing a further £3,500 to reserve for repayment of Debentures, we carry forward, subject to excess profits duty, a sum of £33,841 11s. 1d.

Effects of Abnormal Conditions: Necessity of Wireless Telegraphy at Sea.

Having regard to the fact which I have already mentioned, that our business is being conducted at the present time under very abnormal conditions, that our telegraphic receipts are very much below what they would be in ordinary circumstances, that the losses incurred and debited to profit and loss account are considerable and would not arise in times of peace, that in consequence of the continual and substantial growth of our business generally our profits show a substantial increase, we have considered ourselves fully justified in paying a higher dividend, and we feel sure that this can at least be maintained. Except in such abnormal times as these, we are not subject in our business to any material variation in our figures in consequence of fortuitous circumstances, activity, or slackness of trade. We provide what is an absolute need, to the great importance of which each year has given more marked demonstration, and I would tell you without question that this last year has given greater proof than in any previous time of the extreme utility, if not the absolute necessity, of a wireless telegraph installation on board every merchant ship; and I think I can go yet a step farther and say that not only is it essential that every ship should be equipped with wireless telegraphy, but overwhelming evidence has been afforded of the importance of a world-wide organization such as this Company has built up. I do not hesitate to say that such an organization never could have been developed efficiently except under one management. The Navy, the Army, and the whole nation can be thankful that such an organization exists and that it is in the hands of a British Company.

The Company's Telegraph Stations.

As we have informed you in our report, the number of telegraph stations owned and worked by the Company as public telegraph stations on the high seas—which has reference, of course, to merchant ships only—had increased at the end of December, 1915, to 1,008. At the present time it is between 1,100 and 1,200, and this number is increasing day by day as fast as it is possible to turn out and fit the installations. If progress is not greater at this moment, it is only in consequence of the existing circumstances and the exigency of other demands.

Present Position of the Company.

This, gentlemen, is the position of your Company to-day. We have a sound industrial business, which, in my opinion, can only progress, and which I think after the war will develop more quickly than hitherto. I would remind you, however, that this position has not been obtained without a very great struggle. Those of you who have followed the history of this Company since its inception some 16 years ago will remember the innumerable difficulties which have been encountered, how slow was the country to appreciate the value of the work which the Company had taken in hand, and how dangerously near one was to the whole business falling into foreign hands. It required some courage on the part of the shareholders to face an expenditure of upwards of £200,000 over a period of years before one penny of profit was earned. One cannot help thinking what a different state of things might have existed had this company shown less enterprise. It gives one hope that the lessons of this war will lead to national assistance, should it again fall to the lot of a British Company, situated as this Company was, to develop a new science and a new industry destined to become of such paramount importance to the nation.

I do not suppose that the work of any man has ever been responsible for the saving of so much life, and I am very sorry indeed that Mr. Marconi is not here to-day to tell you of his new work. His recent developments will dispose of one more peril of the seas. He authorizes me to inform you that in the very near future he will introduce a new, independent, and very simple apparatus, to be worked from the bridge of a ship, and by one of the ship's officers, which should put an end to all danger of collision in darkness or fog. He has described this new work to me, and I have little doubt that every seagoing vessel will be equipped with this further great invention of Mr. Marconi, and, turning to the practical business side of the question, this should prove of no small value to your company.

Bravery of the Telegraph Operators.

Gentlemen, I cannot close without reminding you that we have in our employ in these perilous times some 2,000 young men almost continuously upon the seas, and I think it speaks volumes for the great inherent qualities of our young men from the moment they are given serious occupation and responsibility that in no single instance has one of them been found wanting in the moment of peril. It is true that we are at some pains in selecting men for this service, and inquire thoroughly into their records, both at school and subsequently, of their parentage and of their home life, and it is significant that all these young men, born of respectable parents, no matter how humble may be their station, have borne themselves admirably in all circumstances.

It will interest you, perhaps, to hear two or three instances. In July last year the Lords Commissioners of the Admiralty presented a gold watch to Mr. J. F. Rea, operator in charge of the wireless installation on board the s.s. *Anglo-Californian*, for his devotion to duty in remaining at his post in the wireless cabin during the time the *Anglo-Californian* was heavily engaged and shelled by a German submarine. The junior operator, Mr. W. G. Williams, was highly commended for his splendid conduct in going down into the stokehold and assisting the engineers in keeping up steam when the

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stokers had refused to go below. Both Rea and Williams stuck to their posts, although heavily bombarded for hours. In another case the captain of a ship, which for reasons I will not name, desired to report to us how well pleased he was with the splendid work of the operators, Messrs. Weselby and Ingle, and that he desired that his appreciation be put on record. These operators were on board a ship which was captured and boarded by officers from the cruiser *Emden*. The enemy carried off the accumulators, telephones, and coil back contacts; they cut down the aerial and threw the wire overboard. When the ship was released the operators, with great intelligence and ability, reconstructed their apparatus and were soon in communication with a coast station, which secured the safety of the ship. Another instance is the case of the s.s. *Armenian*, where the senior operator, Mr. J. S. Swift, rendered great service. While the ship was being chased and shelled he remained at his post sending calls for help until the wireless cabin and the aerial were destroyed by shell fire. He subsequently showed the greatest calmness and presence of mind upon leaving the ship and in the boat during the night. The captain wrote: "I can highly recommend him as a man of good character, sobriety, and of being most attentive to his duties at all times." There is another case which I must mention—it is that of our wireless operator, Mr. Proughton, who was on the s.s. *Zent*, which was torpedoed on April 5 of this year. The protest lodged by the captain contains a very fine story of the heroism and self-sacrifice of Mr. Proughton. "But for his gallantry and devotion to duty," it is stated, "not a single life would have been saved. He remained to the last in his wireless cabin, and was never seen again," but he succeeded in bringing help to the others. There are many more such instances, but it is impossible to recite them all. I am sure you will all agree with me in being proud of such men. They vie with the Navy and the Army in proving that there has been no decline in the spirit of our race.

It will interest you to know, further, that 82 of our operators were employed on mercantile ships which have been sunk by the enemy. Three were drowned, two have been seriously injured, and seven have been slightly injured; and of the operators whom we have transferred to the Admiralty service, I am sorry to say that seven have already lost their lives.

Services of the Manager and Staff Warmly Commended.

Before formally moving the usual resolution, there is one word more I feel I must say, and that is how very highly the Directors appreciate the great ability shown by Mr. Bradfield, our Manager, during all these troublous and difficult times, and the untiring attention given by the Heads of the Ship Department, Mr. Cross and Mr. Lewis, and all the Staff working under them. Shareholders will well understand that all the men essential for the conduct of a business of such immense importance in these times have been retained, and that the work which they do is of no less importance than that of any man who is rendering other service to the country. It was a duty, however, to release every man that could possibly be spared, and this naturally has thrown much longer hours and greater responsibility upon all the members of the staff who have remained behind. I have nothing further to add, gentlemen, and I now beg to move: "That the report of the Directors submitted, together with the annexed statement of the Company's accounts at December 31, 1915, duly audited, be received, approved, and adopted." I call upon Captain Sankey to second the resolution.

Captain Henry Riall Sankey, C.B., R.E.: Gentlemen, I have much pleasure in seconding the motion.

The Chairman: Before formally putting the resolution, I shall be very pleased to answer any questions that any shareholder may desire to ask. After a pause, and no shareholder rising to address the meeting, he continued: If there are no questions I will now formally put the resolution, and will ask those in favour of it to signify the same in the usual way. Against. Carried unanimously. It is now my pleasure to move: "That Senatore Guglielmo Marconi and Alfonso Marconi, Esq., the retiring Directors, be re-elected Directors of the Company." I need not say anything to you, I am sure, in support of that proposal.

Mr. Henry S. Saunders seconded the motion, which was carried unanimously.

Captain Sankey: Mr. Chairman and Gentlemen,—Obviously, from the comparatively small attendance at this meeting, the shareholders have great confidence in the Directors. The Directors also have great confidence in the shareholders, because every year they have to ask for their fees, and therefore I have much pleasure in proposing the following resolution: "That the remuneration of the Directors for the year 1916 shall be the sum of £2,000, subject to such further sum, if any, as may be determined at the next general meeting of the Company." This sum is divided among the Directors by the Accountant, who uses a mysterious formula, but the result is quite satisfactory to the Directors.

Mr. Alfonso Marconi seconded the motion, which was carried unanimously.

The Chairman: I now have pleasure in moving: "That a final dividend of 7½ per cent., equal to 1s. 6d. per share, less income-tax, upon the capital now issued and paid up, be and the same is hereby declared for the year ended December 31, 1915; that the said dividend be payable on July 7, 1916, to the shareholders registered on the books of the Company at June 13, 1916."

Captain Sankey seconded the resolution, which was carried unanimously.

On the motion of Mr. David Morgan, seconded by Mr. Charles Lucas, Messrs. Cooper Brothers & Co. were re-elected Auditors for the ensuing year, and the proceedings then terminated.

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Dr. BALANCE SHEET,

	£ s. d.	£ s. d.
To CAPITAL—		
Authorised—		
1,250,000 Ordinary Shares of £1 each ... £1,250,000 0 0		
250,000 7 per cent. Cumulative Participating Preference Shares of £1 each ... 250,000 0 0		
£1,500,000 0 0		
Issued—		
1,222,688 Ordinary Shares of £1 each, fully paid	1,222,688 0 0	
250,000 7 per cent. Cumulative Participating Preference Shares of £1 each, fully paid	250,000 0 0	
		1,472,688 0 0
„ BILLS PAYABLE		11,716 10 6
„ SUNDRY CREDITORS		154,648 12 3
„ RESERVE FOR EXPENSES UNPAID AND PAYMENTS IN ADVANCE AND OTHER CREDIT BALANCES		34,663 16 6
„ GENERAL RESERVE ACCOUNT		667,530 0 6
„ PROFIT AND LOSS ACCOUNT—		
Balance as per Appropriation Account, 31st December, 1914 ...	69,497 8 6	
Profit for the year as per Account	377,817 12 1	
		447,315 0 7
To Contingent Liability on Shares in Associated Companies £50,862 10s. 0d. and Liability under an Agreement		
		£3,088,562 0 4

Report of the Auditors

We have audited the above Balance Sheet with the books in London and accounts from Rome. The entered in the Balance Sheet at £23,986 1s. 3d. and shares of the nominal value of £1,354,518 14s. 5d. out that these shares are held on behalf of this Company. This item also includes shares for which certificates opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the the books of the Company.

LONDON, 19th June, 1916.

Dr. PROFIT AND LOSS ACCOUNT for

	£ s. d.
To RENTS, RATES, TAXES, TRAVELLING, PUBLICITY, GENERAL EXPENSES AND WAR SUBSCRIPTIONS	20,047 7 1
„ SALARIES OF STAFF, CONTRIBUTION TO STAFF SUPERANNUATION FUND AND DIRECTORS' REMUNERATION	72,834 17 1
„ LAW CHARGES, PROFESSIONAL FEES AND PATENT EXPENSES	14,936 19 8
„ LOSS ON EXCHANGE AND DEPRECIATION ON INVESTMENTS	53,363 8 2
„ DEPRECIATION OF PLANT, MACHINERY, BUILDINGS AND FURNITURE	19,175 14 1
„ FOREIGN AGENCIES EXPENSES	4,037 12 11
„ STATION EXPENSES	19,451 18 7
„ BALANCE BEING PROFIT FOR THE YEAR CARRIED TO BALANCE SHEET	377,817 12 1
	£581,665 9 8

Dr. APPROPRIATION

	£ s. d.
To DIVIDEND OF 7 PER CENT. ON PREFERENCE SHARES FOR THE YEAR ENDING 31ST DECEMBER, 1915, paid 1st February, 1916	17,500 0 0
„ INTERIM DIVIDEND OF 5 PER CENT. ON ORDINARY SHARES FOR THE YEAR ENDING 31ST DECEMBER, 1915, paid 1st February, 1916	61,134 8 0
„ PROPOSED FINAL DIVIDEND FOR THE YEAR ENDING 31ST DECEMBER, 1915, ON THE ORDINARY SHARES AT THE RATE OF 5 PER CENT. PER ANNUM	61,134 8 0
„ BALANCE CARRIED TO NEXT ACCOUNT	307,546 4 7
	£447,315 0 7

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31st December, 1915. Cr.

	£ s. d.	£ s. d.
By Cash at Bankers and in Hand		76,829 19 0
„ Investments and Temporary Loans Against Securities ...		443,848 14 3
„ Sundry Debtors, Debit Balances and Expenditure on Foreign Developments		749,074 2 1
„ Stock at Cost or Under as certified by Officers of the Company		159,647 6 5
„ Freehold Works at Dalston	38,419 6 1	
Deduct Mortgage	12,611 12 4	
		25,807 13 9
„ Freehold Property at Chelmsford and Plant, Machinery and Buildings at Chelmsford and Genoa Works		99,829 19 1
„ Long Distance Stations in England and Ireland (including Stores) and Movable Plant at other Places		120,109 7 6
„ Expenditure on Leasehold Premises, Office Furniture and Fittings, London, Chelmsford and Foreign Agencies		29,757 3 9
„ Shares in Associated Companies and Patents		1,383,657 14 6

Shares held in Associated Companies are of a par value of £2,484,369 14s. 10d.

HENRY S. SAUNDERS, *Director.*
S. GEOGHEGAN, *Director.*

£3,088,562 0 4

to the Shareholders.

item, Shares in Associated Companies and Patents, includes shares held abroad without nominal value of a total nominal value of £2,484,369 14s. 10d. Except as to a small part we have seen letters stating have not been issued. We have obtained all the information and explanations we have required. In our Company's affairs according to the best of our information and the explanations given to us and as shown by

COOPER BROTHERS & CO., *Chartered Accountants,* } *Auditors.*

the Year ending 31st December, 1915. Cr.

	£ s. d.
By Balance of Contracts, Sales and Trading Account	581,125 8 2
„ Transfer, Share Warrant and other Fees	540 1 6

£581,665 9 8

ACCOUNT. Cr.

	£ s. d.
By Profit and Loss Account—	
Balance Brought Forward as per Appropriation Account for 1914 ...	69,497 8 6
Profit for the Year as per Account	377,817 12 1

£447,315 0 7

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Marconi Wireless Telegraph Company, Ltd.

Report of Directors and Statement of Accounts

THE Directors herewith submit the Balance Sheet and Profit and Loss Account for the year ending December 31st, 1915.

The Profit and Loss Account for the year shows a gross profit of £581,125 8s. 2d., and a net profit carried to Balance Sheet of £377,817 12s. 1d., an increase of net profit over the preceding year of £145,101 3s. 2d. The net profit, added to the sum of £69,497 8s. 6d. brought forward from the previous year, increases the balance now to the credit of Profit and Loss Account to the sum of £447,315 0s. 7d.

The Directors regret to have again to inform the Shareholders that they are still without an agreement as to the basis of remuneration and compensation from the Government for the use of the Company's high-power stations since the beginning of the war, and for the other services rendered in connection therewith. It has therefore been once more impossible to include any sum in respect of these matters in the accounts. There have been, however, a large number of contracts entered into by the Company with Government Departments in respect of all of which payments have been regularly received.

There are four heads under which considerable sums are payable by the Government to the Company, viz. :—

1. The Post Office, for remuneration and compensation in respect of the use of the Company's high-power stations since the beginning of the war, the staffing and management of those stations, and other services in connection therewith.

(It is hoped that a substantial payment on account may be received shortly.)

2. The Admiralty, for the use of the Company's patents since the expiration, on the 31st March, 1914, of the Admiralty agreement of 1903, no new agreement having yet been concluded.

(There have been difficulties in arriving at a settlement of this matter and delay has been unavoidable. We have, however, received an assurance that every despatch will be given to deal with the matter as quickly as possible.)

3. The War Office, in respect of the use of the Company's patents, without agreement, during the whole time Wireless Telegraphy has been used by the War Office.

(This matter is about to be referred to the Treasury for settlement under the Patents and Designs Act, 1907.)

4. The Post Office, for compensation in respect of their withdrawal from the contract for the Imperial chain of stations, with regard to which no agreement has been arrived at, and the Company has therefore been obliged to leave the amount of compensation to which it is entitled to be settled by a Court of Law.

Shares in Associated Companies and Patents, following our usual custom, are taken at their cost price, viz., £1,383,657 14s. 6d., which shows an increase of £23,531 19s. 2d. The Company's holdings in Associated Companies, except for some additions, have undergone no change during the past year. The par value of the shares held in Associated Companies, as shown in the margin, now stands at £2,484,369 14s. 10d., exclusive of shares which have no capital denomination.

After crediting £100,000 allocated from Profit and Loss Account of the preceding year, the General Reserve Account now stands at £967,530 0s. 6d.

The Marconi International Marine Communication Company has continued to show substantial development of its business and a further increase in profits. Dividends for the past year amounting to 12½ per cent. have been declared and the sum of £33,841 11s. 1d. has been carried forward.

The Russian Company, Société Russe de Télégraphes et Téléphones sans Fil, has continued to do a large business. A dividend at the rate of 15 per cent. for the year 1915 has been declared.

The French Company, La Compagnie Française Maritime et Coloniale de Télégraphie sans Fil, has declared a dividend for the year 1915 at the rate of 10 per cent. on the Ordinary Shares and 31.25 francs on the Founders' Shares.

The Amalgamated Wireless (Australasia) Limited has paid a dividend of 6 per cent. in respect of the year ending 30th June, 1915.

The Wireless Press Limited has paid a dividend of 25 per cent. in respect of the year ending September 30th, 1915.

The Marconi Wireless Telegraph Company of America has again earned increased profits for the past year, but its principal revenue is expected to be derived from the Transatlantic Service, which, in consequence of this Company's stations being in Government service, has been obliged to remain idle. It is apprehended that the compensation to be received in respect of this Company's Carnarvon stations will also embrace the loss incurred by the enforced idleness of the American stations.

Owing to the unfavourable rates of exchange large sums of money have had to be placed on deposit with foreign banks, principally in allied countries, until such time as the exchanges become normal. Had these moneys been remitted on the 31st December last there would have been a loss in exchange of £25,757 2s. 5d. Temporary investments at the end of the year showed a depreciation of £27,606 5s. 9d. It has, therefore, been deemed right to debit to Profit and Loss Account both these sums, which amount to £53,363 8s. 2d. There have since been substantial improvements, and it is contemplated that if held until hostilities cease the loss will be completely recovered. In the event of eventual realisation without loss, the amount so written off will appear as profit in another year.

In view of the state of war and having regard to the large sums of money abroad, and to the uncertainty as to when any of the moneys due to the Company from the Government will be received, your Directors deem it prudent to husband their resources, and recommend the declaration of a final dividend upon the Ordinary Shares at the rate of 5 per cent., which, together with the 5 per cent. interim dividend paid on the 1st February, 1916, will make 10 per cent. for the year. They will, however, further recommend that a substantial bonus shall be declared and paid out of the moneys due from the Government as soon as they are received.

The Directors retiring at this meeting are Captain H. Riall Sankey and Mr. Alfonso Marconi, who, being eligible, offer themselves for re-election.

The Auditors, Messrs. Cooper Brothers & Co., also retire and offer themselves for re-appointment.

By Order of the Board,
HENRY W. ALLEN,
Secretary.

Marconi House, Strand, London, W.C.,
19th June, 1916.

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Marconi Wireless Telegraph Company, Ltd.

Account of General Meeting

THE Nineteenth Ordinary General Meeting of Marconi's Wireless Telegraph Company (Limited) was held on the 30th June, at the Hotel Cecil, Strand, Mr. Godfrey C. Isaacs (the managing director), presiding.

The Secretary (Mr. Henry W. Allen, F.C.I.S.) having read the notice convening the meeting and the report of the auditors,

The Chairman said: Ladies and Gentlemen,—I have this morning received a telegram from Senatore Marconi, in which he says: "Please express my great regret that duties here prevent my attending general meeting." Mr. Marconi is in Rome. I am sure you will all regret that he is not here, but I am equally sure that there is nobody, in the circumstances, who would have it otherwise.

Explanation of the Accounts.

I propose, with your approval, to adopt the usual course of taking the report and accounts as read, and will proceed at once to deal with the figures of the balance-sheet and profit and loss account. Turning first to the balance-sheet, there is no change since last year in the capital. The bills payable and sundry creditors show reductions this year of some £8,000 and £16,000 respectively. The general reserve account now stands at £967,530 os. 6d., which is £100,000 more than the figure at which this item stood in the accounts of last year. On the credit side, cash at bankers and in hand shows an increase of some £20,000 in round figures; investments and temporary loans exceed the previous year's figures by £173,500; sundry debtors, debit balances, and expenditure on foreign developments have increased by the sum of £23,000; the stock taken at cost is slightly reduced; there are also reductions in the figures representing freehold works at Dalston, freehold property at Chelmsford, machinery and buildings at Chelmsford and Genoa Works, long-distance stations, and leasehold premises. These have in most cases been added to by some additional expenditure, but the amounts written off in every case exceed the sum expended. The shares in associated companies and patents show an increase of between £22,000 and £23,000 in consequence of our having acquired some additional interests. Otherwise, there is no change; all the shares held at the end of 1914 were held in 1915. They appear in the balance-sheet, according to our habit, at cost, but have a par value of £2,484,369 14s. 10d., which excludes some shares representing a substantial value, but the shares having no capital denomination do not figure in this total. Turning to the profit and loss account, the balance of contracts, sales, and trading account shows an increase of some £210,000 over that of the preceding year, and the net profit of £377,817 12s. 1d. is an improvement over that of the preceding year of some £145,000.

The Question of Depreciation.

I have no doubt you will all consider these figures, in the circumstances, as highly satisfactory, particularly when one bears in mind that there are many substantial items not yet settled with the Government, which are therefore not included in the figures of last year, and in addition we have written off the sum of £53,000 in respect of depreciation of exchanges and investments. But this item, it must be borne in mind, does not at the present moment represent a loss, inasmuch as no actual loss has been incurred in exchange, as it has not been necessary to bring home from abroad the moneys which are lying at banks upon interest, nor has it been necessary for us to sell the investments which, had they been realised on December 31st, 1915, would have resulted in a loss. There is every reason to suppose that before it will be necessary for us to bring home our moneys from abroad exchanges will have become normal or thereabouts, and before we require to realise our securities, which are with one exception gilt-edged securities, it is possible that we shall realise not only the cost price, but a substantial profit. The one exception to which I have just referred showed a loss on December 31st of some £13,000. This investment was certainly not what is termed a gilt-edged security, but it is one of an absolutely sound nature, and was made for the purpose of assisting our business. The price at December 31st last was a nominal one, but it was the only guide which we had. If we had to deal with the figures to-day instead of at December 31st last, not only would that £13,000 loss have disappeared, but there would be a profit upon the shares, and as time goes on we are confident that that profit will increase. We have therefore every hope that the item of £53,000 will appear as a profit in a future account. There is only one thing that I perhaps might add, and that is, that had we not treated this sum as a loss at December 31st, 1915, our profit and loss account for this year would have been the record in the history of the company. I think there is nothing more which I need say relating to the account, but if there are any other explanations regarding the figures which may be required, or which I may have omitted, if my attention is drawn to them I shall be very glad to give further particulars.

Last Year's Working and the War: "Considerable Business with the Admiralty."

Our business during the year under review has certainly not been normal. There is considerable work in certain parts of the world which we should have been doing, but which it has been impossible to do in consequence of the war; on the other hand, we have had some compensation by having many additional orders at home and from Allied countries.

In particular we have done considerable business with the Admiralty, and nothing could have been more agreeable than the relations between the company and that Department, and I am glad to say that this feeling is reciprocated by the high officials with whom we have had to deal at the Admiralty. They have told me how deeply they are indebted to us and to our staff and to all the employees of the company for their consistently admirable and prompt work on their behalf; their wishes, they say, have always been met immediately and cheerfully, and no trouble has seemed too great to supply them with exactly what they wanted at the shortest possible notice; that they have been grateful for the prompt response to their sometimes very urgent requests for skilled operators at a moment's notice, and which responses must have been of great service to the Empire. I am sure you will be pleased to learn, too, that I have been told that no company has served the Admiralty better. It has been a source of great gratification to me, as I am sure it will be you, to know how

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much those with whom we have had to do at the Admiralty have appreciated our work. We, the company, and you, Ladies and Gentlemen, as shareholders, are not alone in owing a deep debt of gratitude to Mr. Bradfield and to others of his staff who have been mainly responsible for the carrying out of that work.

The Associated Companies: The New Transatlantic Service.

Our associated companies have not been able, in consequence of the war, to make the progress which they otherwise would have done. This applies particularly to our Spanish and Argentine companies, to the Relay Automatic Telephone Company and to a considerable degree also to the American Company. The new direct Transatlantic service with New York, which was ready to open when war broke out, and to which we both have attached the very first importance, has continued in enforced idleness, the stations on this side having remained in the service of the Government. For this we hope we shall receive due compensation. As soon as the war comes to an end we are confident that this new Transatlantic service should be productive of very considerable revenue to our American Company, besides to our own, which added to the profits which they are now making should soon place them in a position to pay substantial dividends. Independently, however, of this, we have in view, in conjunction with our American Company, a new and very considerable programme, which I am afraid it would be inexpedient for me to divulge at the present moment. I have for some time intended taking the first opportunity of visiting New York in respect of these matters, and had booked my passage for the steamer leaving this coming week. Unfortunately, however, there are so many matters of importance which demand my presence here that I am bound to defer for a little my visit. Others, however, will go in my stead; I shall follow at the earliest opportunity and so soon as I can dispose of pressing matters, to one of which at least I think you will attach some importance, and that is the distribution of a bonus, to which I will refer a little later.

Our Belgian Company, whose business Captain Sankey and I, as directors of that company, have assisted to direct, has been unable again to make up any balance-sheet, and I am consequently unable to give you any information with regard to the results, and we have therefore also received no dividends.

Our programme in respect of the Canadian Company has also been obliged to remain in abeyance meantime.

The French Company has continued to do a satisfactory business, and has paid dividends equivalent to those of the preceding year.

The Marconi International Marine Communication Company, notwithstanding its considerable losses, has shown an increased profit, and is making excellent headway, and I am glad to be able to say that in the case of this company it has been able to pay an increased dividend. Mr. Turnbull, who has been largely responsible for the management of this company's affairs, is entitled to special credit.

Our Russian Company has continued to be extremely busy, and has declared a dividend for the past year at the rate of 15 per cent., with which we have every reason to be well satisfied. We can congratulate ourselves upon the choice of the member of our staff, Major Simpson, who has acted as managing director of that company ever since our inception of it, and nothing I can say can speak more eloquently of his direction than is indicated by the results achieved and the dividends paid.

The Spanish and General Trust has suffered very naturally in consequence of the war, but I hope ere long part of the programme of that company will be realised, and I may be able to add its name to those from which we are receiving revenue in the shape of dividends.

The Wireless Press, which all of you must have observed has been very prominent in all the daily papers, has developed an excellent business under the very able management of Mr. H. W. Allen, our secretary, who is mainly responsible for its successful development.

We have continued to do an important business with the Italian Government through our Italian Agency, under the energetic and able management of the Marquis Solari, who represents the company in Italy. His unswerving loyalty to the company and the able manner in which he conducts its affairs are deeply appreciated by the directors.

The Dividend: A Conservative Policy.

I now come to matters in respect of which I am sure you will expect to hear something from me. We have had an excellent year, and having £447,315 0s. 7d. to the credit of profit and loss account, we are distributing only a small proportion of this amount, carrying forward £307,546 4s. 7d., and you will, no doubt, want to know why we are adopting this course.

I do not think I can do better than remind you of what I said upon this subject last year. I then told you, after having described to you the nature of the competition with which the company had had to contend in the past and the many difficulties with which they have been confronted from time to time, that I had given you that information in order that you should better understand the reasons for the conservative policy which the board had determined to follow, and I added that we contemplated that when this war is over, in consequence of the great utility which wireless telegraphy has proved itself to be, there will be a very considerable business to be done with a great many foreign countries, and that in consequence of the financial position which may then obtain, it was, in our view, essential that we should be in the strongest possible position to undertake business in all parts of the world without the necessity of requiring immediate payment therefor. That position has not changed to-day, except perhaps to be more accentuated. In harbouring our resources, therefore, we are satisfied that we are unquestionably acting in the best interests of the company. Had we known our position with regard to the several matters in respect of which we have to receive payments from the Government we should have been able to be more generous in the distribution which we are recommending. Until we know a little more of that position it is better for us to act conservatively.

"Considerable Sums" Due by the Government.

There are, as we have told you in our report, four heads under which considerable sums are payable by the Government to the company, in respect of which also you will no doubt look to me to give you some more information than is furnished you in the report. The first of these is the remuneration and compensation which is due to us from the Post Office, acting on behalf of itself and other Government Departments, in respect of the use of the company's high-power stations since the beginning of the war, the staffing and management of these stations, and other services in connection therewith.

The remuneration to which we think we are entitled is certainly a very considerable sum. The

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services which we have rendered I cannot go into in detail, but I do not suppose there is a single member of the public who has not some appreciation of their magnitude. There is one thing, however, which I think I may be permitted to tell you, and which will not only interest you, but also give you some idea of the extent and usefulness of our work. To the end of December, 1915, we had handled foreign messages in transmission, reception, and delivery which represented in the aggregate a total of, in round figures, over 20 million words.

As regards compensation, you are aware that we had just completed the construction of our Carnarvon and Towyn stations, and also in America the American Company had just erected its New Brunswick and Belmar stations, all of which represented a very considerable outlay, for the purpose of opening a direct telegraph service between Europe and America. Traffics during the period of the war have shown very considerable increase, and there is no doubt whatsoever that the business we should have done would have been on a very large scale indeed, and the profit which we have every reason to expect we should have realised each year since the outbreak of war would have, in our estimation, run well into five figures. We are of opinion that we should receive a substantial sum to compensate us for this loss, and we have every hope that the Government will appreciate the value which our stations and our services have been to the nation, and remunerate and compensate us fairly if not generously. I have every hope that this matter will be settled in the very early future. On Monday morning last I was glad to have had the assurance of the Postmaster-General that these questions were receiving his earnest consideration, and every endeavour would be made to deal with them at once.

Claims under the Patents and Designs Act.

Under item (2) of the report is our right under the Patents and Designs Act, 1907, to receive payment from the Admiralty in respect of the use of our patents since the expiration of the agreement on March 31, 1914. We have supplied the Admiralty with a very considerable number of installations since the outbreak of war under contract, and the royalty in each of these cases has been defined and paid, but there have been infinitely more installations which were already fitted and others which have been constructed by the Admiralty themselves in respect of each of which a substantial sum is payable to us. In cases where we supply the Admiralty with installations we, of course, make a manufacturing profit in addition to the royalty payment; it is therefore fair to assume that, where we have not had the opportunity of making the manufacturing profit, the royalty to which we should be entitled should not be less than in cases where it is accompanied by a manufacturing profit. The agreement which was made with the Admiralty in 1903 came to an end on March 31, 1914, and there is no single installation in the use of the Admiralty since that date which is not using patents which are our property and in respect of which, therefore, we are not entitled to receive payment, except in such cases as I have already mentioned, where payment has already been made. We have every reason to believe that a fair and equitable settlement of these matters will be made at the earliest possible moment. That such a settlement has not yet taken place we in no way complain, for there have been certain matters of some complexity which required to be dealt with, and which will be dealt with, I hope, very soon, before we could arrive at an agreement as to the payments to be made to us.

Under Number (3) of the report there is a similar claim upon the War Office. We have never had any agreement with the War Office in respect of the use of the Company's patents, and up to the time of the war there had been some use of our patents, but not on a large scale. An offer was made to us in 1912 which was less per installation than what we have since been receiving from the Admiralty, and which we did not feel justified in accepting. Since the war the use of the Company's patents has been very considerable indeed. There has been an immense number of installations supplied to the War Office from outside sources and a very large number also manufactured in the factories of the War Office, all of which come under our patents. In our interpretation of the Patents and Designs Act of 1907 there should have been a genuine endeavour to agree with us the payments which were to be made to us in respect of the use of these patents. Having regard, however, to the immense increase in the work of the War Office during the war, we must, perhaps, not complain that there has been no endeavour to arrive at such an agreement, and that it is left to the Treasury under Article 29 of the Patents and Designs Act of 1907 to decide what is the royalty to which we are entitled. As we have informed you in our report, this is a matter which is now being referred to the Treasury, and we hope that ere long it will be disposed of.

The Post Office and the Contract for the Imperial Chain of Stations.

The fourth item to which we have made reference —namely, payment from the Post Office for compensation in respect of their withdrawal from the contract for the Imperial chain of stations—is by far the most important matter of all, and I had hoped that it would have been possible to have arrived at satisfactory terms which would have avoided the necessity of my saying more than a few words to you upon this subject. Unfortunately, however, we have not been able yet to arrive at terms which we consider we should have been justified in accepting on your behalf, and it therefore is my duty to-day to tell you what Mr. Marconi would have told you last year had it not been that we were then in negotiation for a new agreement, and contemplated that these negotiations would have been fruitful.

You will remember that in the Directors' report issued in 1914 we informed you that we had been permitted to make but slow progress with the six high-power stations for which we had contracted with his Majesty's Postmaster-General, and that the Company's interests were being seriously prejudiced thereby. At the general meeting last year our Chairman informed you that at the end of 1914 the Company received letters from the Postmaster-General informing them that, owing to the altered circumstances resulting from the war, the Government had decided not to proceed with the Imperial wireless chain; that the governing factors in determining the Imperial scheme would be better met by means other than the construction of stations of the character and in the situations contemplated by the contract for the Imperial chain; and that the amounts disbursed by the Company in respect of the contract would be refunded. He further told you that subsequently, in February, 1915, negotiations were entered into with his Majesty's Government for the erection of certain stations on conditions differing from those in the original scheme, that negotiations were proceeding upon a basis which, if agreed to, would represent to the Company a reasonable equivalent of the terms of the 1913 contract, but, he added, nothing, however, has yet been definitely decided. This statement, ladies and gentlemen, before it was made to you received official approval.

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CORRESPONDENCE WITH THE POSTMASTER-GENERAL.

After receiving, on December 31st, 1914, from the Postmaster-General, the intimation of the intention to withdraw from the Imperial contract for the reasons given, to which I have already referred, some correspondence took place with respect to the compensation which the Company should receive, which resulted in our being informed by the Secretary of the General Post Office that inasmuch as the Company took up the position of claiming compensation, the Postmaster-General, on behalf of the Government, unconditionally withdrew his letters and was prepared to co-operate in carrying out the terms of the contract of 1913 with all possible promptitude. In a subsequent communication of January 21st, 1915, we were informed that the Postmaster-General was willing to proceed with the construction of all the six original stations. I would remind you that we had been informed just before this that the Government had decided not to proceed with the construction of the stations of the Imperial chain owing to the altered circumstances resulting from the war, and that the governing factors in determining the scheme could be better met by means other than the construction of stations of the character and in the situations contemplated by the contract for the Imperial chain of 1913. Upon these and other considerations it was quite evident that not only was there no urgency for the construction of these stations, but that they were not, in fact, required.

Ladies and Gentlemen,—We declined the Postmaster-General's offer to reinstate the contract, notwithstanding all the importance which you and we have always attached to it. I am sorry that it would not be right for me at this moment to make public all the reasons for the course which we took. They will, no doubt, be given on another occasion elsewhere. Were I able to tell you all that you must one day know, I am satisfied that you would unanimously agree that we were not only justified, but wise in the decision we took.

NEW NEGOTIATIONS.

In February, 1915, as you will remember Mr. Marconi told you last year, new negotiations were entered into with his Majesty's Government. On this occasion, however, these negotiations were not with the Post Office, but with the Admiralty, and in consequence of its being represented to us that four of the original stations were urgently needed, and although the conditions offered to us were in my view less favourable than those of the 1913 contract —the number of stations being reduced from six to four, and the duration of the contract shortened—I felt myself constrained, in view of its national importance, to undertake to recommend my colleagues to accept the basis proposed for the new agreement. The draft of this agreement was to be submitted to us promptly and the stations were to be proceeded with immediately. I have told you that, in my opinion, the new agreement proposed was far less favourable to the Company than was the contract of 1913, but owing to the urgent need for the immediate construction of the stations, I did not feel justified in being the cause of any delay in their being erected and I believe that you would have approved the course I was then adopting, to the detriment of the Company, but in the national interest.

Ladies and Gentlemen,—When we met you last year, and when the Chairman made the statement he did on the question of the Imperial contract on July 26th last, we were daily expecting to receive the draft agreement. No draft agreement has ever been received. The Company has never yet been officially informed why this draft agreement has never been submitted to us. After several inquiries without result and many more months of patient waiting, we realized that there was no alternative but to proceed with our claim for compensation. We therefore took the necessary steps to this end, and I am prevented from discussing subsequent matters. To sum up what I have already said, however, whereas your Directors in early 1915, believing the stations to be urgently needed, were of opinion that they were warranted in making a heavy sacrifice, to-day, in all the circumstances, some of which I have described to you, they are convinced that in your interests they are not called upon and cannot conscientiously agree to make that sacrifice.

This, Ladies and Gentlemen, is all that I feel I can publicly say to-day upon this subject. Whether we are able to arrive hereafter at an agreement or not, there is every reason to hope that the whole matter may be dealt with and disposed of before the end of the year. But we are not in any sense depending upon a settlement of this matter to carry out our promise to you of a substantial bonus. We look to any one of the items under one, two, or three of the report for this purpose. As I have told you, we are of opinion that we are entitled to a very large sum under each of these heads, and whichever one of them is settled first should enable us to carry out our promise. It will, of course, be understood that both classes of shares will receive whatever bonus it may be decided to pay.

LOYAL SUPPORT OF THE OFFICERS AND STAFF.

Before moving the resolution I must tell you how sensible are the Directors to the loyal support which they have received from all the officers of the Company and to every member of the staff, without exception, in the Company's employ. The work which they have done has been of the first importance, not only to the Company, but to the country. Very many of our staff are in Government service, many are with his Majesty's forces in the field, and we owe a deep debt of gratitude to them and to those who have rendered equal service at home.

MR. MARCONI'S RESEARCH WORK IN ITALY: "FAR-REACHING RESULTS."

There is but one other matter to which I want to make reference before I sit down, and I think you will agree with me that it is certainly not the least important. You will remember that on April 3rd last we informed you by circular that Mr. Marconi had been engaged in research work in Italy, where he had been able to carry out some important improvements and tests. The results obtained were far-reaching, and directly concerned the future practice of the entire science of wireless telegraphy and wireless telephony over both long and short distances, no matter whether conducted by means of ordinary sparks, quenched sparks, or continuous waves, and that by this means results hitherto impossible would be obtained. This information was sent to you with the express authority of Mr. Marconi. Since then he has been able to pay a visit to this country and has described to me the nature of this new work. I announced at the general meeting of the Marconi International Marine Communication Company, which was held a couple of weeks back, that in the very near future Mr. Marconi would introduce a new, independent, and very simple installation, to be worked from the bridge of a ship, which would put an end to all danger of collision at sea in darkness or in fog. This represents but a part of Mr. Marconi's latest work. It is my belief that his new inventions will prove as epoch-making in the progress of the art of wireless telegraphy as was in 1900 the now world-famous patent known as the four sevens.

Ladies and Gentlemen, I now formally move: "That the report of the Directors submitted, together with the annexed statement of the Company's accounts, at December 31st, 1915, duly

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audited, be received, approved, and adopted." I call upon Captain Sankey to second the resolution.

Captain H. Riall Sankey, C.B., R.E.: Ladies and Gentlemen, the shareholders of this company generally expect to get some important information at the annual meeting, and I think they will not have been disappointed this year. You have also had some sort of indication of the difficulty the directors, and more particularly the managing director, have had in working the affairs of the company; and I should like to express, as I have now the opportunity of doing so, my great admiration of the way in which Mr. Isaacs has conducted the negotiations referred to. Really the way in which he does things is almost miraculous, but I think his great strength is his absolute honesty of purpose and the straightforward way in which he deals with matters. I feel sure that the shareholders can absolutely rely on the way in which he will conduct the business of the company. I believe that the 20,000,000 words to which Mr. Isaacs referred have been since the beginning of the war; it does not say so in the report, and it may be worth while to note the point. I would also like to say one word about the works, as I am one of the directors more particularly concerned with them. I should like to assure the shareholders that they have in those works one of the best-equipped works in this country for the business they have to do. I should also like to say that Mr. Mitchell, the works manager, is a most capable man for the work. I do not know anyone who could do the work better than he. I beg to second the resolution.

The Chairman: Before putting the resolution formally to the meeting I shall be glad to reply to any questions which any shareholders may wish to put to me.

THE DISCUSSION.

Mr. S. P. Derbyshire: Mr. Chairman, the Marconi Company was established to work one of the most amazing inventions that the brain of man ever devised in the history of the world, and in consequence of its uncanniness it brought upon itself from its inception the most scathing criticism. Had the great Marconi lived in olden days he would have been burnt at the stake as a wizard. The people of this generation did not act quite in that manner towards him, but instead of acclaiming him as one of the greatest benefactors the world has ever known, they did not scruple to use him and his associates as a whip with which to attempt to flog prominent political personages. You may say —Why bring that matter before us to-day? Why bring up something we are all too well acquainted with and wish to forget? Because, ladies and gentlemen, I can detect to-day in the public Press many indications that the spirit which so harassed our directors several years ago is not yet dead. We have heard to-day from our chairman a most lucid report of the many difficulties which we as a company have had to contend with, and we are told that at some future time we may be paid a bonus of 5d. per share, or 5s. per share, or £5 per share—we know not what—and what does the Press say about it? In that great organ the *Daily Mail*—it is a great organ—you find it everywhere—I read: "The situation again places Marconi shares in a fine position for speculative manipulation." Whose fault is that? Surely, not ours. We have heard how the directors have laboured for many months past to settle the matter with the Government, and no impartial person can say that it is our fault that our shares to-day are in a position for manipulation. Perhaps we ought not to complain of the remarks of the City Editor of the *Daily Mail*, but rather accept them as a tribute to his insight and broad grasp of the position. But I do feel that we have a right to complain of the way the Government has treated us. The last thing any shareholder in this company would like to do is anything that would inconvenience the Government of this great Empire at this time. Speaking personally, for my small interest in the company, I would make them a present of it willingly if I thought it was in the national interest, but I do feel that our interest ought to be carefully attended to by the Government, and I beg of them to give some little attention to us and enable us to continue the great work which we are doing in the interests of the Empire. This is to-day the opportunity—the only annual opportunity—the shareholders have of meeting together, criticising the balance-sheet, and expressing any views they may have with respect to the conduct of this company's business, and my first note must be that I feel sure I express the feeling of the shareholders when I say that our predominant feeling is one of deep gratitude to the directors for the balance-sheet they have been able to lay before us and for their report. Turning to the details of the balance-sheet, I have one or two criticisms to offer. I should very much like to be told what the parent company itself earned, and how much we get by way of dividends from the shares we hold in the associated companies of the par value of nearly two and a half millions sterling. The chairman later on will probably give us a full answer to that question, so far as he feels he is at liberty to do so, but I do not wish to press him to give us any information which might inconvenience him in the conduct of the company's business. Again, I observe that the balance-sheet is a very good one, but I notice that there is one slatternly little item in it which I very much object to. Here, with assets of £3,000,000, we appear to have a mortgage down Dalston way of £12,600. Do, Mr. Chairman, before you go to New York, go to Dalston and pay off that mortgage, even if you are not entitled to pay it off at a month's notice. Give the mortgagee a share or two or a bonus and pay him off, and let us see that we have no mortgage in our balance-sheet. In conclusion, I have three requests to make. First, will the Press please leave us alone? They had a good innings a year or two ago; give us a miss in baulk now. Secondly, will the Government please pay us our little bill? Thirdly, will the directors please continue to pursue their successful policy of building up one of the finest businesses in the world?

Mr. John Waring: Mr. Chairman, I think it was in 1914 that I told Mr. Marconi, our splendid managing director, and our directors, that I had every confidence in their bringing this company to the position in which we find it to-day. Now I desire to thank Mr. Marconi, our managing director, and our directors for the splendid report which they have placed before us to-day, and I thank them all. I am pleased to say that I still hold the same number of shares to-day—namely, 300, which I held then, and I thank you all for the patience you have displayed in connection with our affairs. I am sure that we have every confidence in you, and that you will do great things for us.

Mr. F. M. David: May I ask, Mr. Chairman, two short questions? Referring to the 20,000,000 words, does that include all means of transit, such as the high-power stations in the employ of the Government, and so on; in other words, all means of transit? With reference to Mr. Marconi's new patents, or the one referred to in the circular, are they two different patents or discoveries or one—in connection with avoiding collisions at sea?

Mr. Lanham: Mr. Chairman, the last item on

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the balance-sheet reads something like this: "Shares in associated companies and patents, £1,300,000 odd," and in a line later you give the information that these are of a par value of so and so. I am not much of an expert in financial matters, but to me, Sir, that conveys very little. What we should like to know, I think, is the cost to us and the present valuation, which may be entirely different. Then, sir, there is one small point I should like to ask a question about with respect to Mr. Marconi's new inventions. We have read the circular and heard from the chairman to-day that Mr. Marconi has made these discoveries, but so far as I have been able to understand, there is little indication as to what the connection is between those patents and this company. Mr. Marconi has been clever enough to make this invention, but does it follow that this company is to get the benefit of it, and if so to what extent? Up to the present it seems to me that that point has been rather evaded, and, for anything which has so far been said, this company might have nothing whatever to do with it. It appears to me that that is a little point on which you might kindly give us some information.

Mr. Barnes: Mr. Chairman, I should like to ask whether, with regard to these Post Office questions, they have paid for the salaries and out-of-pocket expenses, or whether the company has borne all that outlay and has charged it up; and the same with the disbursements in connection with the wireless business. I understand that these outlays must have been very considerable in both cases, and I understand that they have been charged in the company's accounts, but that nothing has been received from the Post Office or the other Government offices mentioned. Then, as regards the compensation, I think we shall all be very glad indeed if that matter can be settled without going to litigation. We shall all be very thankful indeed if the company can keep out of the Law Courts, and I think we all rather feel that we would prefer to give the Government something rather than take anything from them at the present time, if only from a patriotic point of view. With regard to your investments, I should like to ask whether there is any amount in them representing War Loans.

THE CHAIRMAN'S REPLY.

The Chairman: With regard to the first question put to me, relating to dividends on shares, I do not think it would be advisable to state at a public meeting what is the amount of the dividends which we receive on shares, or to give any information which would enable one by dissecting our figures to arrive at information which it is not desirable he should have, but if any shareholder thinks it is worth his while, and he cares to come and see me at the office, I shall be very pleased to give him the information. As regards the mortgage, I quite appreciate the feeling of the shareholder who spoke upon that subject, but it so happens that this is a mortgage which was arranged many years ago, and under it we pay, as you have probably remarked from the accounts, £1,000 every year, and it is gradually in process of extinction. I do not like the look of that small item, considering the large sums of money which we have available, but on the other hand, as business men, having arranged this matter many years ago, when money was very cheap, I do not think it is quite advisable to give them the benefit of that arrangement to-day. In reply to another shareholder, those 20,000,000 words embrace all the words we have actually handled for the Government since the commencement of the war until the end of 1915 through the stations which we are managing on their behalf. It does not, of course, touch our own Transatlantic service. A question was asked as to whether Mr. Marconi's new invention embraces one or two patents. I am afraid I cannot tell you. I am not at all sure that the one patent, which is, and, presumably, will be the master patent, may not cover the use of those patents for many purposes besides those which I have in my mind, and which I have already announced; but I do not think it necessarily means that there should be more than one patent. In any case, this work has been carried out in Italy, and protection has been applied for in Italy first. I have not yet seen the provisional specification, and I hope it will be quite a long time before anything is made public with regard to the details of that work. The longer it remains where it is, the better for us and the worse for Germany.

THE VALUE OF THE SHARES IN THE ASSOCIATED COMPANIES AND PATENTS.

With regard to the question relating to the last item in the balance-sheet, "Shares in associated companies and patents," a shareholder said that that gave him very little information, but I am afraid he has not observed what we have said every year in our report, and which I feel sure we have not omitted to say this year. On page 6 you will see we say, "Shares in associated companies and patents, following our usual custom, are taken at their cost price." Therefore, although the balance-sheet does not say so, the report tells you that that figure represents the cost of all the shares you hold, and, in addition, the cost of all the patents you hold. To give you a valuation of those shares, particularly in times such as these, would be, I am afraid, a responsibility which is greater than I would care to take upon myself, inasmuch as we have a good many shares which are not quoted—a good many shares, in fact, which have never been heard of. They represent interests in different businesses, and I do not think it would be possible for us to arrive at a valuation with such accuracy as would be necessary if we had to make a statement as to what the value of those shares is. But I think shareholders know in a general way what the shares we hold mainly consist of. They know that we have a large number of shares—I think, speaking from memory, it is very nearly 200,000—in the Marconi International Marine Communication Company. Well, they have a market for those shares, and they can form their own opinion as to what they are worth. I believe they are worth at the present moment about £2 per share. We have, speaking again from memory, about £200,000 nominal value of shares in our Russian company. Well, those shares pay a dividend of 15 per cent. Everything that could be written off has been written off. We have a magnificent freehold property, and we consider the value of those shares to be not less than that of the International Company's shares. Then we have a large number of shares in the Canadian Company, and those are quoted; also in the Spanish Company, and those are quoted; as well as in the American Company, and those are quoted, so that in a general way the shareholders can arrive pretty well at what is the value, which is, of course, a changing value, of the shares we hold. I do not think it would be possible for us to attempt to give a valuation of them. It will perhaps satisfy the shareholder who asked the question if I tell him that the realisable value of those shares to-day would far exceed the cost price.

THE OWNERSHIP OF MR. MARCONI'S PATENTS.

The other question, I think, was as to Mr. Marconi's patents or his inventions, and to whom they belong. Well, ladies and gentlemen, I thought

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that all the shareholders knew that the agreement which was entered into by this company with Mr. Marconi at the inception of the company provided for the company having all improvements that Mr. Marconi may ever make in relation to wireless telegraphy or telephony other than in Italy; and as regards Italy the arrangements which then obtained between Mr. Marconi and the company, which required the omission of Italy, have changed. We have made other arrangements with him, and we are therefore interested also in the patents in Italy.

A Settlement with the Government Desired Without Litigation.

In reply to the question as to whether we have been reimbursed the salaries and our disbursements in respect of the out-of-pocket payments which we make in the running of the stations for the Government, recently, or comparatively recently, we have been paid the greater part of our out-of-pocket expenses, and we are paid from time to time cheques on account of those expenses. As regards the disbursements on the wireless stations which we partly erected under the Imperial contract, we have been paid a substantial part of our outlay, but the matter has not yet been finally settled. I am very much in sympathy with the shareholder who hoped that we might arrive at a settlement with the Government without having recourse to the Law Courts in respect to this action. I had hoped to have made it very clear in my opening speech that I have done nothing else but endeavour to make such a settlement, and I am still disposed to endeavour to make such a settlement; but what I said, and what I think you will approve, is that whilst we are very desirous of making this settlement, and we are even willing to make something of a sacrifice to obtain that settlement, we are not disposed to-day to make the sacrifice which we were disposed to make twelve months ago, when we thought the matter was of urgent national importance. The last question had relation to our investments. We have, ladies and gentlemen, a very large sum indeed invested in War Loan.

The resolution was then put to the meeting and carried unanimously.

The Chairman: I now have to move, "That a final dividend of 5 per cent., less income-tax, upon the Ordinary shares now issued and paid up be and the same is hereby declared for the year ended December 31st, 1915; that the said dividend be payable on August 1st, 1916, to the shareholders registered on the books of the Company on June 29th, 1916, and to holders of share warrants to bearer."

Mr. Alfonso Marconi seconded the motion, which was unanimously agreed to.

Mr. Henry S. Saunders: The next resolution is, "That the retiring Directors, Captain H. Riall Sankey and Mr. Alfonso Marconi, be re-elected, Directors of the Company." As you are all aware, the great bulk of the work must fall on our capable and valuable Managing Director, Mr. Isaacs, also on Mr. Marconi, our illustrious Chairman and inventor, but I think that every Director is doing his best in this Company for your interests, and I am sure that the two gentlemen whom I ask you to reappoint render most valuable services. I have, therefore, much pleasure in proposing that resolution.

Mr. Samuel Geoghegan seconded the motion, which was carried unanimously.

Mr. Alderman J. C. Ford (of Cork): I have much pleasure in proposing, "That Messrs. Cooper Brothers & Co. be re-elected Auditors for the ensuing year, and that their remuneration for auditing the accounts to December 31st, 1915, be 600 guineas."

The motion was seconded by Mr. Bagster and unanimously agreed to.

The Chairman: Ladies and Gentlemen,—I think this concludes the business of the meeting.

The Chairman, Directors, and Staff Cordially Thanked.

Mr. Alderman J. C. Ford: Before you do conclude the meeting I think it would be very ungrateful indeed on our part if we did not move a vote of thanks to Mr. Isaacs for the able manner in which he has conducted this meeting. It is a source of satisfaction to us, Mr. Chairman, that in the absence of our great inventor, Senatore Marconi, you are here to-day to take his place worthily and well. Many things have been said here to-day, but we can all thank you for the encouraging way in which you have portrayed the position of the Company at the present moment. A number of questions were put to you, Mr. Chairman, in connection with Mr. Marconi's recent inventions, but as far as I could see your mouth was closed owing to the Defence of the Realm Act; but I think any man watching the papers carefully could see the answer for himself. During the past week you have seen in the papers that the premium on shipping war risks has decreased by two-thirds per cent.; that is, that the premium of £3 per cent. of last week has been reduced to £1. That speaks volumes. We do not know what the reason is, but the fact is there. You were good enough to mention that the Admiralty had expressed their thanks to the staff. Well, I think we should be ungrateful on our part if we did not ask you, Mr. Chairman, to convey to the staff our grateful thanks for the manner in which they have worked the concern. Any shareholder who has from time to time gone into the office of the Company has experienced nothing but courtesy from every member of the staff, from the head down to the humblest member, so it is only right and fair that a vote of thanks should be accorded to them. Mr. Chairman, you have placed everything before us in an exhaustive manner, and I am sure that every shareholder present here and those who read the proceedings of this meeting to-morrow will be pleased. The only thing we have to hope is that after all the vicissitudes we have gone through the Government will now make up a little leeway by at least "forking out" the money which is due to us as quickly as possible.

The vote was unanimously accorded.

The Chairman: Ladies and Gentlemen,—On behalf of the Directors, as well as on behalf of the staff, I thank the last speaker for his kind remarks. I am sure we all very much appreciate them.

The proceedings then terminated.

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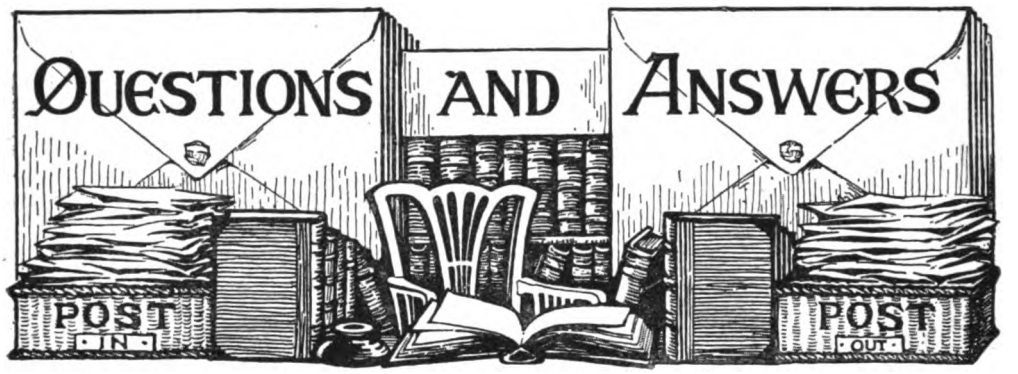

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

SPR. M. F. G. (Flanders).—Your friend is right. Poldhu transmits the Press bulletins automatically by means of Wheatstone tape.

A. E. B. (York).—*The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, *Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, are both books which your son should study. To enter the engineering side of the profession he would have to have practical engineering training at a recognised technical college. Write to the Chief Engineer, Marconi's Wireless Telegraph Co., Ltd., for a list of approved colleges.

R. F. (Manchester).—For answers to your questions see the article on "How to Become a Wireless Operator" in our issue for August last.

H. C. (Wallasey).—We do not think the authorities would object. The best thing to do would be to write to the G.P.O. for permission, saying what apparatus you propose to use. We think it would be granted. (2) Yes, if it were a sensitive one.

V. E. S. (Barry Dock).—You cannot join any section until you are nineteen.

V. E. S. (Victoria, Australia).—(1) Selenium can be obtained from any of the big dealers in scientific apparatus if you order it. (2) Yes, we should think so. (3) Yes. Vol. I and back numbers can be ordered through Messrs. Gordon & Gotch from the Wireless Press, Ltd. We are glad you appreciate the "Questions and Answers" Columns.

"SPARK" (Moate, Co. Westmeath), who says that the mathematical Instructional Articles are the very plainest and easiest to understand that he has ever read, asks whether it is our intention to publish them in book form.

Answer.—Yes; these articles will be published in book form as soon as the series is completed.

J. L. W. (Stockport) asks whether Leclanché cells would run themselves down if connected in parallel instead of series. This question shows that our correspondent is not clear in his mind as to what is meant by connecting cells in series and parallel. Whether cells run themselves down or not depends on other things besides the way they are connected. We would refer J. L. W. to Chapter IV. of the *Handbook of Technical Instruction for Wireless Telegraphists*, where the subject is very clearly treated.

A. H. K. (Exeter).—There is no book *How to Join the Wireless Service*, but you will find in our issue of August last an article which will probably give you all the information you require.

WINGS (Birmingham).—Your assumption regarding the uniform of wireless operators in the Navy is correct.

D. M. (Cardiff).—If the iron core were not laminated it would heat up considerably, but a properly laminated iron core would certainly not melt. The answer to the question is quite

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sufficient, the object being merely to find whether the student realises the main effect of introducing an iron core.

F. A. D. (Hornsey) writes: "In your June "issue I see one of your correspondents has had "permission to have a tapping key and buzzer, "also a pair of head receivers. May I ask "what is the use of the receivers, as you can "hear the buzzer quite distinctly without "them?"

Answer.—It is quite true that the buzzer can easily be heard without the receivers, but students who learn from a loud buzzer often experience difficulty in reading signals when they first put on the telephones. For this reason it is usual to learn from the beginning from signals in the telephone head piece, as signals heard in this way very closely resemble those which the operator has to read in an actual wireless installation. By far the best book for a beginner is the *Elementary Principles of Wireless Telegraphy*, by R. D. Bangay.

F. H. (Peckham).—We would advise you to obtain THE WIRELESS WORLD for August last, in which you will find an article dealing fully with the life of a wireless operator, and giving much valuable information on the subject.

E. J. E. H. (Berks.).—The arrangement of opposed rectifying circuits for the elimination of atmospherics is not new, and several varieties of it have been tested from time to time. Theoretically the idea is a pleasing one, but in practice loss in strength of signals and difficulties of adjustment have given great trouble. One of the best of these arrangements, which was patented by the Marconi Company some years ago, consisted in coupling inductively two receiving circuits to the aerial, one being adjusted to the signals required, and the other being placed slightly "off tune." The signals required were supposed to confine themselves to one circuit only, and the atmospherics were presumed to affect both circuits equally. The signals from the two detectors were then opposed to one another with the idea of causing the atmospherics to "balance out." The trouble is that a balance which is right for some atmospherics is wrong for others, and in all cases there is great difficulty in obtaining a good balance. We are sorry we have not space to go fully into the interesting subject raised in your second query, but a series of practical tests carried out in the United States some while ago showed that the series method was the better, and in tuning an aerial with a condenser shunted across the inductance the efficiency diminished as the size of the parallel condenser was increased. The best way is to have the condenser of fairly big capacity in series with the aerial, as is done in the Marconi tuners.

W. H. R. (B.E.F., France).—To deal with your query fully and to do justice to it would need many pages of this magazine. There is no difference in the underlying principles of the two systems, although the Marconi apparatus is by far the more robust, fool-proof, and the easier to handle. The system to which you refer has in its transmitter a motor generator of 500 cycles, tubular condensers, flat spiral direct coupled jigger and quenched spark gap. The spark frequency of a thousand gives a high piercing note, which, whilst it carries through atmospherics very well, is very tiring to the ear when it has to be read for a long period, as you have probably found. On the receiving side there is an inductively coupled tuner with no intermediate circuit, and no tuning condenser in the detector circuit. Crystal detectors are used with high-resistance telephones. It is not possible to "break in" as with the Marconi apparatus; the change from sending to receiving is effected by means of a switch, and not automatically. These are a few of the main points. If this information is not sufficient we will try to give more if you will put definite queries to us as to what you require to know.

H. M. (Toulon).—All the latest improvements in the Marconi Company's valves, amplifying valves, crystal receivers, direction finders and the like are being used for war purposes, and we therefore much regret that we are unable to give you any information about them at the present time.

H. L. (Mombasa).—The arrangement of circuits suggested by you would not, we think, prove satisfactory. Such relays are unsuitable for wireless work unless the received signals are exceptionally strong. When it is desired to obtain very loud signals it is customary to use some form of amplifier, such as a Marconi amplifying valve or an S. G. Brown telephone relay. In reply to your second question, it is not true that dry wood is a better conductor of high frequency currents than copper. Dry wood is an exceedingly poor conductor of such currents—almost an insulator. Neither is it true that most X's are heard on a 600-metre wave. Sometimes atmospherics are strongest on one wave and sometimes on another. Don't forget that in tuning for long waves on a small aerial a large amount of inductance must be placed in series with the aerial, and this acts to some extent as a choke, reducing the strength of atmospherics. Perhaps this is what has misled you. We are sorry that space will not allow us to give you patterns of variometer for transmitting. See answer to C. M. for some information on this point.

J. W. (Brocklesby).—We cannot pass any opinion as to which is the best wireless school for obvious reasons, but if you will turn to our advertising pages you will find a number of announcements concerning these colleges.

Ch. S. (Las Palmas).—The aerial shown in your diagram is quite a good one for receiving, although we should prefer a "T" aerial with

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extensions *both* ends, and a lead taken down from immediately above the cabin. The wave length of the aerial in your diagram can be calculated in the same way as that of the usual "L" type.

F. A. (Royal Engineers).—There are no books devoted exclusively to directive wireless telegraphy, and the practical details are dealt with only in the pamphlets issued by the Marconi Company for use with the apparatus. These are not supplied to the general public, but we think that you should be able to obtain one through official channels, which will probably suggest themselves to you. We are not aware of any book dealing with the erection of semi-permanent masts, but the Instructional Articles in THE WIRELESS WORLD for May and June, 1914, contain a great deal of valuable information on this subject.

C. M. (Angoulême, Charente).—The so-called "variometer" to which you refer appears to us to be simply a receiving transformer with tappings on the primary and secondary windings brought out to studs, and the coupling varied not by sliding two windings closer together or farther away from one another, but by rotating one inside the other. The name "variometer" is usually applied to a coil, the inductance of which is continuously variable by moving one part in relation to another; thus, if we have two spiral coils connected in series and placed close to and parallel with one another, the inductance will be very different from when the coils are at right angles. By hinging these two coils together, like the covers of a book, the inductance can be varied within wide limits by altering the angle between the two coils. This type of "variometer" is very widely used.

B. V. W. (Cardiff).—There is no book published on the correct procedure to adopt to gain proficiency in Morse signalling as used by wireless operators, nor is there any need for one. If you are able to obtain one of the practice sets referred to and a set of Marconi gramophone records you should be able to obtain proficiency quite easily. While listening to the Morse signals on the gramophone you will learn exactly how they should be sent, and listening to signals in this way will teach you far more than any book could do. In reply to your second question, the Marconi Company has no medical representative in Cardiff, and we are afraid that it would be necessary for the candidate to come to London to be tested by the company's doctor. This, in any case, would have to be done at his own expense, whether he proved suitable or not. In reply to your third question, why not put your other questions directly to us? In reply to your fourth query, the age limit of the Marconi Company is twenty-five years, and for this reason you could not obtain employment with them, although it is just possible that one or two of the shipping companies who employ their own operators might be able to employ you if you were suitably qualified; as, however, the great majority of ships carry operators provided by the Marconi Company your chances are not very great.

I. E. T. (Karachi).—We are afraid that considerations of space, and the fact that your query does not deal with wireless telegraphy, will not allow us to answer your question here, in view of the large number of "wireless" queries we have on hand. It is an interesting subject, however, and we believe something is being done in the way you suggest. Expense is the great trouble.

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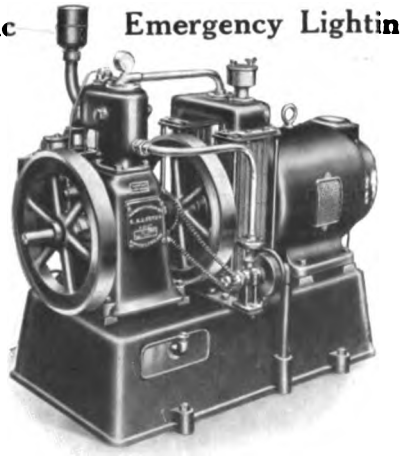

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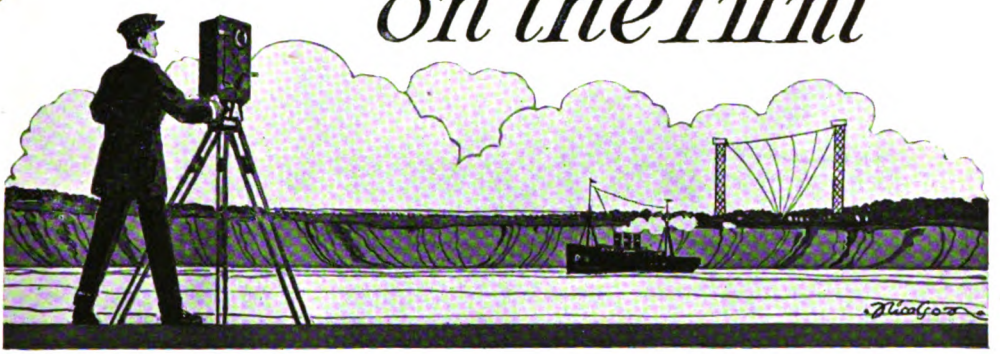
Wireless on the Film



THE wireless telegraph and kinematograph are both essentially modern inventions which have had a far-reaching effect upon our daily life. Both owe much to the genius of young men, and both have been responsible for the growth of organisations vastly greater than the pioneers ever dreamt of predicting.

In its own particular field, the kinematograph has wrought an effect every whit as revolutionary as that of wireless in the realm of maritime affairs. One by one its technical faults have been removed, so that we may now sit through long programmes without the fatiguing eye strain which accompanied so many of the earlier exhibitions; whilst, from the artistic point of view, the modern film is as far removed from the first crude and awkwardly produced pictures as a modern wireless telegraph station is separated from the crude oscillators of Hertz.

Wireless telegraphy has many dramatic possibilities unthought of in connection with the wire telegraph, and it is not surprising that kinematograph producers have from time to time called in its aid in the production of their plays. In most instances, however, the "wireless" portions of the production have been badly handled, the so-called "wireless apparatus" affording considerable merriment to all who are acquainted with the practical side of the science. But competition keen as a knife is gradually eliminating all error and falsity from film productions, and the crudities of the early films will soon be completely forgotten.

A representative of THE WIRELESS WORLD recently had an opportunity of viewing two excellent modern productions—one, entitled "Via Wireless," by the courtesy of Messrs. Pathé Frères, and the other, "Saved by Wireless," by the kindness of "Triangle Plays." The first revealed itself as an exciting drama, and the second as what is known in the trade as "a side-splitting comedy." A few notes concerning both of these plays will, we think, be not without interest to our readers.

The Pathé production, "Via Wireless," is an excellent example of a modern film produced with the greatest care and, by all appearances, a total disregard for cost. It is not difficult to understand how thousands of pounds may be lavished

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upon a single film when we consider that a large number of copies of each production can be printed off, and each copy circulated among a large number of theatres, the rental for three days (a common period) amounting to many pounds. We understand that in the United States alone there are 120,000 moving picture theatres; whilst the number in this country runs into thousands. Colossal sums are thus earned by a single popular production, and in view of competition it is not surprising that exhibitors will have nothing but the best.

"Via Wireless" opens by introducing to us, one by one, and each in an appropriate scenic setting, the chief actors in the drama, and the play itself commences by revealing a meeting of the Cabinet at Washington to consider the coastal defence of the United States. The authorities shortly after call for quotations for one hundred 12-inch guns. The scene now changes to the office of Durant's Steel Works, a large firm who intend to submit tenders. Here the manager is seen to walk in to the Designs Department, with the purpose of instructing his leading draughtsman, Marsh, to put the designs in hand. While talking he notices on Marsh's board the drawings of a new gun which obviously excels those already produced.

Here the dramatic interest of the story commences in earnest, for Pinkney, the manager, sees a fortune in the new gun, and recognises that legally the firm can claim the benefit. He therefore promises Marsh £250 per gun under promise of

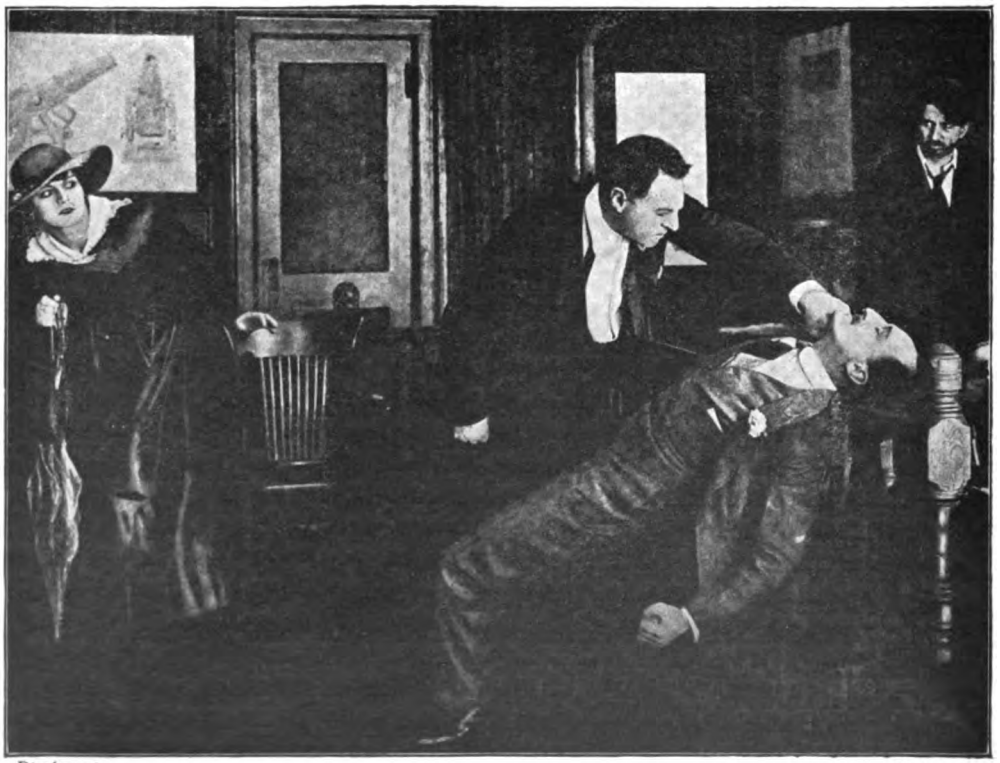

Photo b] [*Pathé Frères.*

"NOT TOO LATE TO THRASH THE VILLAIN!"

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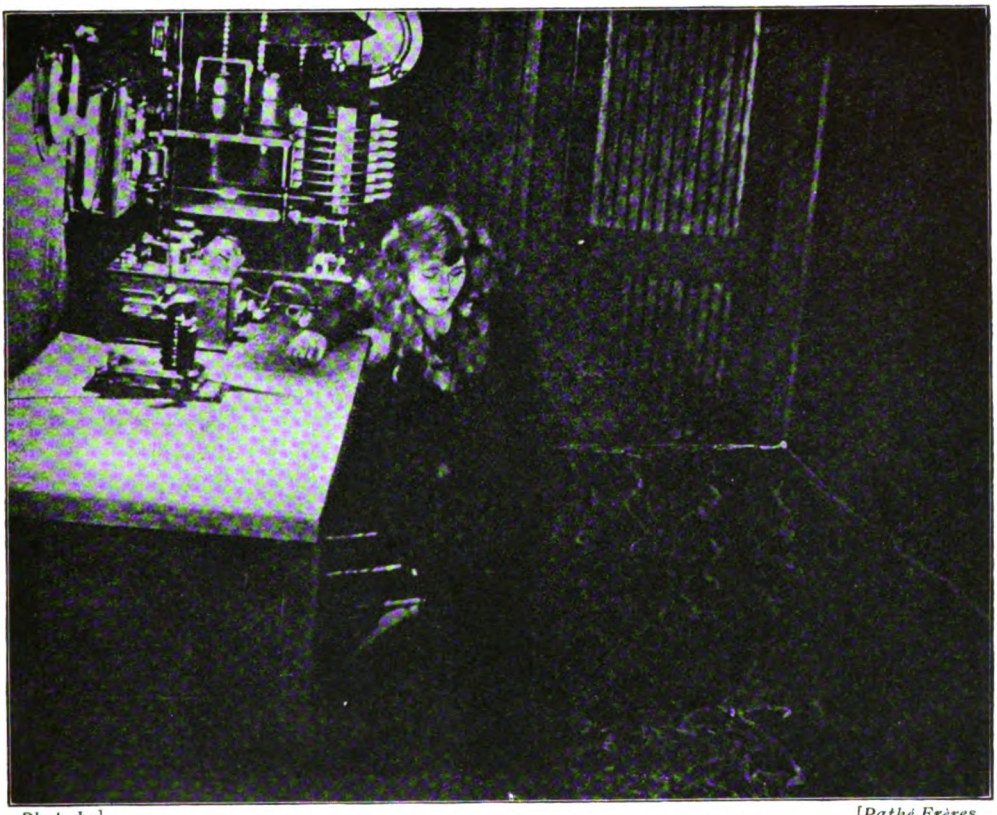

Photo by] [Pathé Frères

"FRANCES . . . SENDS A FRANTIC 'SOS.'"

secrecy, and promptly tries to make double that sum for himself by offering the invention to the firm as the work of an outsider, whom he calls "Ranström." Shortly afterwards Durant's Works are ordered by the authorities to construct one of these new weapons for test purposes, and in the event of trials proving successful an order for a hundred will be placed.

Watching carefully every detail of the play, we now find that the manager loves Frances, the Steel King's daughter, but is treated coolly by her for the reason that Lieutenant Sommers, who has appeared upon the scene, is a much more charming fellow. Whilst we are contemplating the love interest we discover that Sommers' call at Durant's is connected with an order from the Government to construct another test gun from Sommers' own design. Faced with the fact that if the Lieutenant's gun proves more successful than his own he will lose heavily financially, the manager plots to have the second gun ruined in manufacture.

At this point we are treated to some highly interesting pictures of what are supposed to be Durant's Steel Works, and for a considerable time the action takes place amidst flaming furnaces, giant crucibles, and rolling machines, all illuminated by a lurid glow. Here it is evident that we are viewing the "real thing," and we were not surprised on later enquiry to find that these pictures were actually taken in

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the interior of the Pittsburgh Steel Mills, which were placed at the disposal of Messrs. Pathé for the production of these scenes.

Leaving for the moment the gun-production, we find Frances being conducted over a United States battleship by Lieutenant Sommers (in reality the Dreadnought *New York*, on which the Company were permitted to film some of the scenes), and introduced to the wonders of wireless. Here we see a modern wireless installation, complete in every detail. The heroine becomes fascinated with the new art and persuades her father to erect for her a small installation at her own home. Of course the Lieutenant finds this an excellent excuse to pay frequent visits, and takes the opportunity of teaching Frances to send and receive without help. The scenes in the home of the wealthy ironmaster were taken in the palatial residence of Commodore E. E. Benedict, at Greenwich, Connecticut, loaned for the purpose.

A further remarkable series of pictures in the steel works opens with a scene showing the chief draughtsman finding that the foreman in charge of the huge ingot from which Sommers' gun is to be forged is drunk and quite incapable of supervising the details of the work. Hauling him off to the manager, the draughtsman immediately reports the man, expecting, quite justifiably, that he will be immediately dismissed. Instead of this, however, Pinkney plots with the foreman

Photo by] [*Pathé Frères.*

SOMMERS RECEIVES FRANCES' DISTRESS CALL.

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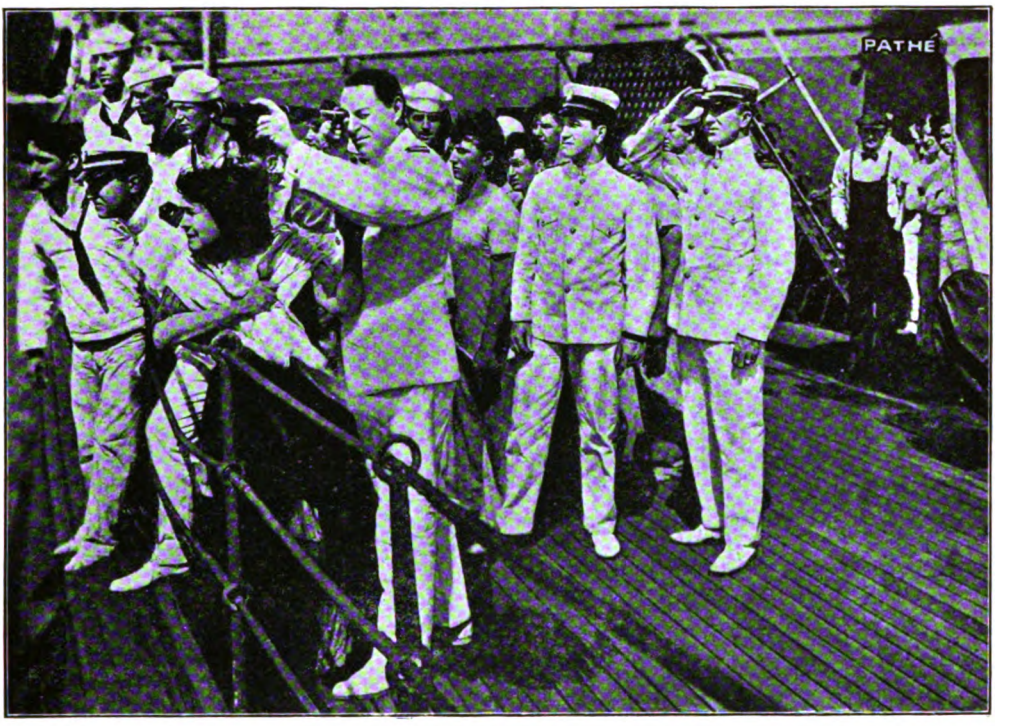

THE WARSHIP CLOSING UP TO THE YACHT.

to ruin the mammoth gun by placing it too early in the hardening bath. Rather than be dismissed, the man accepts the proposal, and as a consequence the giant casting is irretrievably spoilt.

An office-boy overhears the conversation and is able to give Sommers warning of the base plot, and the young Lieutenant immediately rushes to the works, too late it is true to stop the deed, but not too late to thrash the villain who was endeavouring to ruin his fortunes. Still further complications are introduced by the arrival during the " scrap " of the heroine, who mistakes the motives of the young Lieutenant and refuses to see him next morning, when, ordered hurriedly to the Dardanelles, he pays a visit of farewell. Disappointed, as she thinks, in her lover, Frances is inclined to favour the advances of Pinkney, and her father, unaware of the villainies which the manager has perpetrated, does everything he can to encourage the match. To gratify her parent, Frances gives consent, and embarks for a voyage upon her father's luxuriously appointed yacht, with Pinkney and her mother for an escort.

We now see some dramatic pictures of gun-testing, the giant Ranström weapon proving highly successful. The section of the film purporting to show the testing of the Ranström gun was really taken at Sandy Hook during the firing of some coastal defence guns. The Lieutenant's gun, however, bursts at the test, and we have a thrilling scene of the wreckage caused and the havoc surrounding the spot

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where the gun was tried. The scene following the explosion is perhaps one of the most dramatic in the whole film.

A Government enquiry is immediately instituted, and as a consequence Sommers, who was stationed in the Bosphorus (a portion of which we are allowed to see in the film), is recalled; and the manager, who is on the yacht with Frances, is similarly recalled to give evidence. This being a film produced in war time, the dangers to navigation from mines are not overlooked, and we are given a thrilling underwater view of a chained mine, round which the fishes are swimming whilst the bows of the yacht are slowly approaching. Then a violent explosion occurs and the yacht is seen to be sinking rapidly.

Frances, ever keen on wireless, by a lucky chance happens to be in the operating-room at the moment of the explosion, which so wedges the door that she is unable to get out. Meanwhile the cowardly manager, forgetful of his *fiancée*, leaves the yacht with all the crew. Frances makes good use of her wireless knowledge and sends out a frantic "SOS" through the ether, which providentially is intercepted by the cruiser on which Sommers is returning. Dramatic scenes take place in both wireless rooms, where modern American Marconi apparatus is installed, as will be seen from our illustration.

Once in safety aboard the warship, Pinkney remembers that Frances is still aboard, but by this time Sommers has learnt the fact for himself, and is soon speeding to the rescue in a fast motor-boat. Arriving in the nick of time, he saves the brave girl, and, as is to be expected, reconciliation takes place.

Several other thrilling events take place before the Committee of Enquiry meets, and secret service men have made searching enquiries which go to prove Pinkney's guilt. At the enquiry, which takes place at the works, the implicated draughtsman goes mad and fires the building, and in the ensuing panic the villain escapes in a motor-car, of which, however, he loses control and dashes, car and all, over a precipice to be smashed to pieces below. The remaining episodes need not be described except to remark that they are rather touching.

THE ASSISTANT SPY IS CAUGHT FLIRTING.

Needless to say the play is in parts frankly melodramatic and full of those coincidences round which such stories are written. As described in cold print it may seem far beyond the bounds of possibility, but seated in a comfortable chair before the screen, one loses one's critical powers in the interest of the film and its

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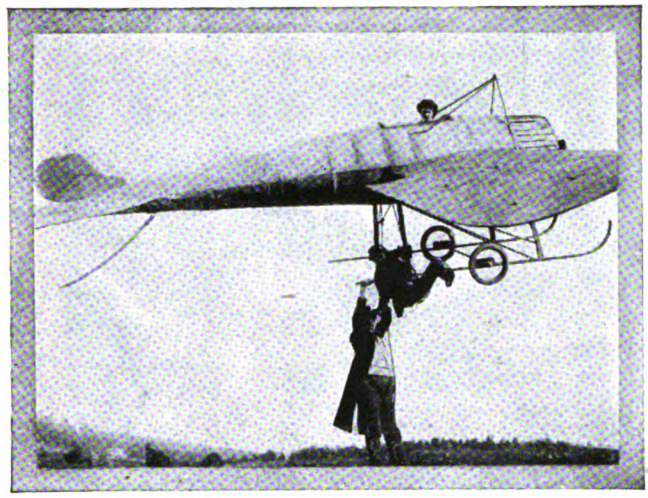
fascinating setting. It must be stated, however, that wherever practical wireless is introduced it is properly handled, and although the operators are obviously not sending "Morse," the effect is sufficiently real to satisfy all but the most exacting. At least we have none of the weird and wonderful imitation wireless apparatus which to a critical eye has ruined so many films. Messrs. Pathé Frères are to be congratulated upon producing a play which is interesting both to the expert and to the general public.



FIGHTING IN MID-AIR.

Of quite a different nature is the film "Saved by Wireless," produced by "Triangle Plays." Here we have a staging almost as elaborate as that of "Via Wireless," but with an interest which is highly comical throughout. It is difficult to record in print the details of the plot, for at the end of the film we are left in a state of nervous exhaustion from the thrills and smashes we have witnessed.

Briefly then, the Minister of War loses his code book through the machinations of an arch-spy, and as usual immediately suspects the wrong person. Complications arise through one of the spy's assistants falling in love with the War Minister's daughter. The arch-spy learns of the defection of his assistant, and throughout the rest of the play a constant struggle takes place between the two. Meanwhile the wrongly suspected youth has eloped on a yacht with the girl, and owing to some mistake or other (we cannot remember exactly how !) a large dynamite bomb is placed aboard the vessel. The love-sick spy sends a warning message by wireless to the yacht and starts off in an aeroplane to the rescue. The arch-spy meanwhile endeavours to wreck the yacht at all costs, and has just extinguished the light in the lighthouse when the lovesick one drops off the aeroplane and switches it on again. Both spies manage to scramble on to the rope suspended from the aeroplane, and there is a struggle in the air, resulting in the chief spy being kicked off into space. He falls through the air for a considerable distance and lands on the yacht, which immediately blows up and ends his career. Providentially the other occupants of the vessel had left a few minutes before.

So far we have omitted all reference to the exciting chase of the aeroplane by the motor-car. Various policemen on motor-cycles and in high-power motor-cars chase the spies and one another, smashing up periodically on greasy roads, until we gasp and wonder how many dozen motor-cars and cycles are wrecked before the

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RECONCILIATION.

film is completed. The wireless apparatus, as in the previous film, is not of the "fake" variety, although the method of manipulating it is not strictly according to the Postmaster-General's Handbook!

Those of our readers who are frequent visitors to motion picture theatres will be acquainted with the two comedians, Mack Swain and Chester Conklin, who play the leading *rôles*, and will agree with us that no funnier comedians could have been chosen for the parts.

Writing of wireless on films reminds us that the British Government have recently issued a series of kinematograph pictures showing how gun-firing is controlled by wireless. Reference to this will be found on another page.

The Marconi War Savings Association.

ON July 18th the London staff of the Associated Marconi Companies held a meeting at Marconi House for the purpose of considering the formation, under the auspices of the National War Savings Committee, of "A War Savings Association." The chair was taken by Mr. Godfrey C. Isaacs, Managing Director, whilst the objects and working of the scheme were admirably expounded by Mr. F. W. Raffety, a speaker attached to the National War Savings Committee. On the completion of Mr. Raffety's remarks, Mr. Isaacs rose and announced that, in order to encourage the staff not only to save but to provide money for the continuance of the war, the company were prepared to offer the assistance of their clerical staff and to advance the entire sum required to meet applications for War Savings Certificates free of interest, subject to such applications being approved and the subscribers undertaking to pay the amount so advanced, within the prescribed period, by weekly or monthly instalments deducted from salary.

Needless to say this kind offer was well received, and a large number of applications have been made. In this way the Marconi Companies' staff will have the satisfaction of knowing that they are contributing to the prosecution of the war not only by their daily duties but also with their savings.

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New Wireless Magazines in Spanish and Portuguese

El Marconigrama and *O Marconigrama*

READERS of our magazine in Spain, Portugal, and South America will be interested to learn that, as already foreshadowed in the Editorial in the August number, it has been decided to publish editions of THE WIRELESS WORLD in both the Spanish and Portuguese languages. The new magazine, the first number of which will be on sale on October 1st, will bear the title *El Marconigrama* for the Spanish edition and *O Marconigrama* for the Portuguese. The contents will follow closely the lines of THE WIRELESS WORLD, and will contain a large proportion of similar matter, although to meet special needs a number of new features will be introduced. The highly attractive cover in colours, depicting a storm-tossed liner sending out into the ether the signal of distress, has been specially prepared by a well-known artist, and will be much admired.

For the first number a particularly interesting series of articles has been prepared. The well-known littérateur Señor Enrique Perez, to whom the editorship has been entrusted, will describe in the editorial pages the aims and aspirations of the new magazine, and among the literary features will be found the translation of Mr. Hall Caine's well-known play " The Iron Hand." As in THE WIRELESS WORLD, there will be instructional articles, technical articles, descriptions of wireless stations in various parts of the world, and all the features which have proved so popular in that magazine. A section of special interest will be that devoted to reviews of books appearing in Spanish and Portuguese.

It is no small tribute to the universality of the interest taken in wireless telegraphy that at such a time as the supreme crisis of the great World War the Wireless Press should feel justified in launching this new enterprise. Labour troubles, paper troubles, and transport troubles notwithstanding, the demand was too insistent to be denied.

The subscription rates will be eight shillings per annum, or $2 American currency, and single copies will be sent post free for 1s., or 20 cents. All communications should be addressed to the Editor, *El Marconigrama*, Marconi House, Strand, London, W.C.

Wireless in the Courts

AN engineer, named H. A. Livermore, has been fined £10 with £5 5s. costs in Australia for being the possessor of wireless apparatus without a licence. The apparatus was of small power, such as would be set up by an ordinary amateur; there were no aerials or detectors, and the apparatus would not receive signals.

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PERSONALITIES IN THE WIRELESS WORLD

Mr. ANDREW GRAY, Chief Engineer, Marconi's Wireless Telegraph Co., Ltd.

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THE chief engineer of the Marconi Company was born in Glasgow in 1873. He received his engineering education at the University and Royal Technical College of that city, winning the diploma of the latter for electrical engineering. His first post was that of assistant to the late Professor Andrew Jamieson of the Royal Technical College (Glasgow), and he afterwards became assistant electrician to the West India and Panama Telegraph Company on their cable steamer *Grappler*. For five years Mr. Gray continued in their service as assistant electrician, chief electrician, and telegraph engineer. During those five years he obtained valuable experience not only of technical matters relating to the laying and repairing of submarine cables, but also of the commercial side and the methods of operating and handling telegraphic traffic. Mr. Gray joined the Marconi service in 1899, and was sent to the Hawaiian Islands to superintend the installation of the Marconi system for the Inter-Island Telegraph Company. Here he had to train the native operators, as well as organise all the traffic arrangements and the methods of operating. In 1901 Senatore Marconi appointed Mr. Gray chief of the staff both for the "Wireless" and "International" companies, and his previous experience proved invaluable in enabling him to initiate and develop the systematic handling of ship and shore traffic. He continued to occupy his dual position until 1906, when the vast extension of the company's operations obliged him to hand over that part of it which appertained to the International Company to the late Mr. G. L. Bullocke. Since then Mr. Gray has been confining his attention to the superintendence of constructional work and the staff engaged thereon. In 1910 he received his formal appointment as Chief Engineer.

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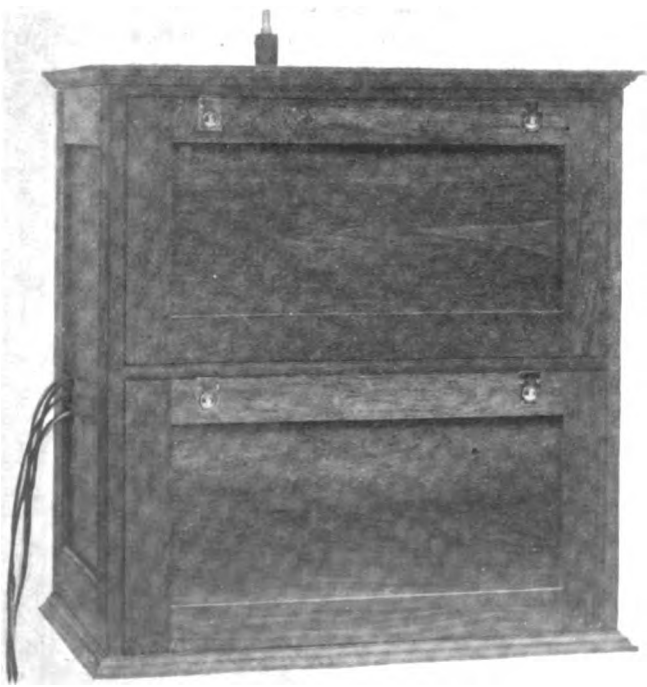
A New Marconi Low-Power Installation

The ¼ kw. Transmitter

THE growth of the application of wireless telegraphy to vessels of small tonnage and the need of a moderate power installation for emergency uses on large vessels has caused the Marconi Co. to put on the market a ¼ kw. installation containing many novel features and characterised by the usual Marconi robust construction and efficiency.

The installation is capable of adjustment for the transmission of any wave-length between 300 and 600 metres, and the whole of the transmitting apparatus, including the motor alternator, is mounted compactly in a wooden cabinet. The cabinet is approximately 27 inches high, 26 inches wide, and 17 inches deep when closed. It is divided into two portions, the larger portion (lead lined) containing the motor alternator and disc discharger, the upper portion serving to hold the condenser battery, primary inductance, aerial tuning inductance, earth arrester terminal, wave shortening condenser, and other details. To protect the apparatus and to prevent inexperienced persons from coming into contact with the high tension circuits, the front of the cabinet is fitted with removable panels, which in general use are kept closed. This necessitates placing the manipulating key and the controlling switch gear outside the cabinet. From the accumulator battery, of which we shall speak later, continuous current is led through the switch gear to the motor alternator, consisting of a continuous current motor directly coupled to a 250 watt generator, which supplies alternating current at a pressure of 110 volts and a frequency of 300 cycles when running at a speed of 3,000 r.p.m. Attached to an extension of the framework of the motor alternator we find a containing chamber for the disc discharger, the disc itself being mounted on an extension of the motor alternator shaft. A suitable combined starter and regulator is furnished for the control of the



¼ KW. WIRELESS TRANSMITTER (CLOSED).

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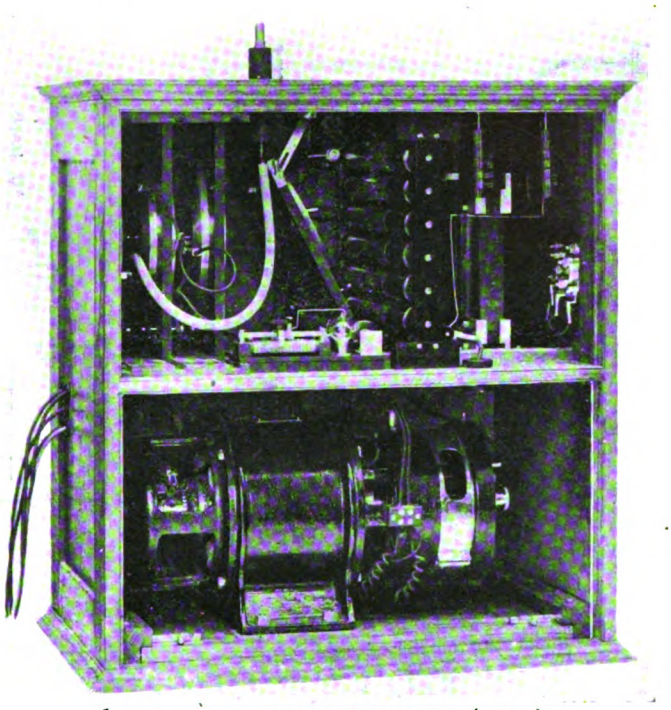
set. The transformer is of the closed magnetic circuit type, air-cooled, and designed to raise the pressure from 110 volts to approximately 5,700 volts (the pressure required for charging the condenser bank). Special air core protecting chokes safeguard the windings of the transformer from injurious induced effects from the high-frequency circuits.



¼ KW. WIRELESS TRANSMITTER (OPEN).

Six tubular condensers are used in the condenser bank. These are constructed of specially selected glass tubes on which has been deposited electrolytically a coating of copper, both inside and out. All of these tubes are of the same dimensions, and are calculated to have the same capacity, and in the unlikely event of a breakdown a new tube can be immediately substituted. The condenser tubes are extremely strong from a mechanical point of view, and have an ample margin of safety for any electrical stresses to which they may be subjected.

One additional condenser unit is furnished for the purpose of tuning the aerial circuit to wave-lengths less than the natural period of that circuit, when the minimum amount of inductance is included therein.

The disc discharger is of the insulated synchronous disc type mounted on an extension of the alternator shaft, and carrying a number of studs bearing a direct relation to the number of alternator poles, thus ensuring correct synchronisation of the spark frequency to the periodicity of the alternating current supply, and the consequent production of a spark of good quality and even tone. The spark frequency is 600 per second (twice the periodicity of the supply from the alternator).

The disc, as mentioned above, is enclosed in a casing formed on the body of the machine, and carrying the stationary electrodes, which are suitably insulated. Provision is made for the adjustment of these electrodes to meet normal wear and to enable the correct phase relationship with the alternating current supply to be obtained.

The transmitting jigger is of the independent primary and secondary circuit type. The primary winding consists of a flat spiral of bare copper strip mounted on a suitable framework by means of ebonite insulating supports, connections being made at various points on this spiral by means of substantial clip connectors, thus enabling the amount of inductance included in the high-frequency primary circuit to be varied to suit the required wave-length.

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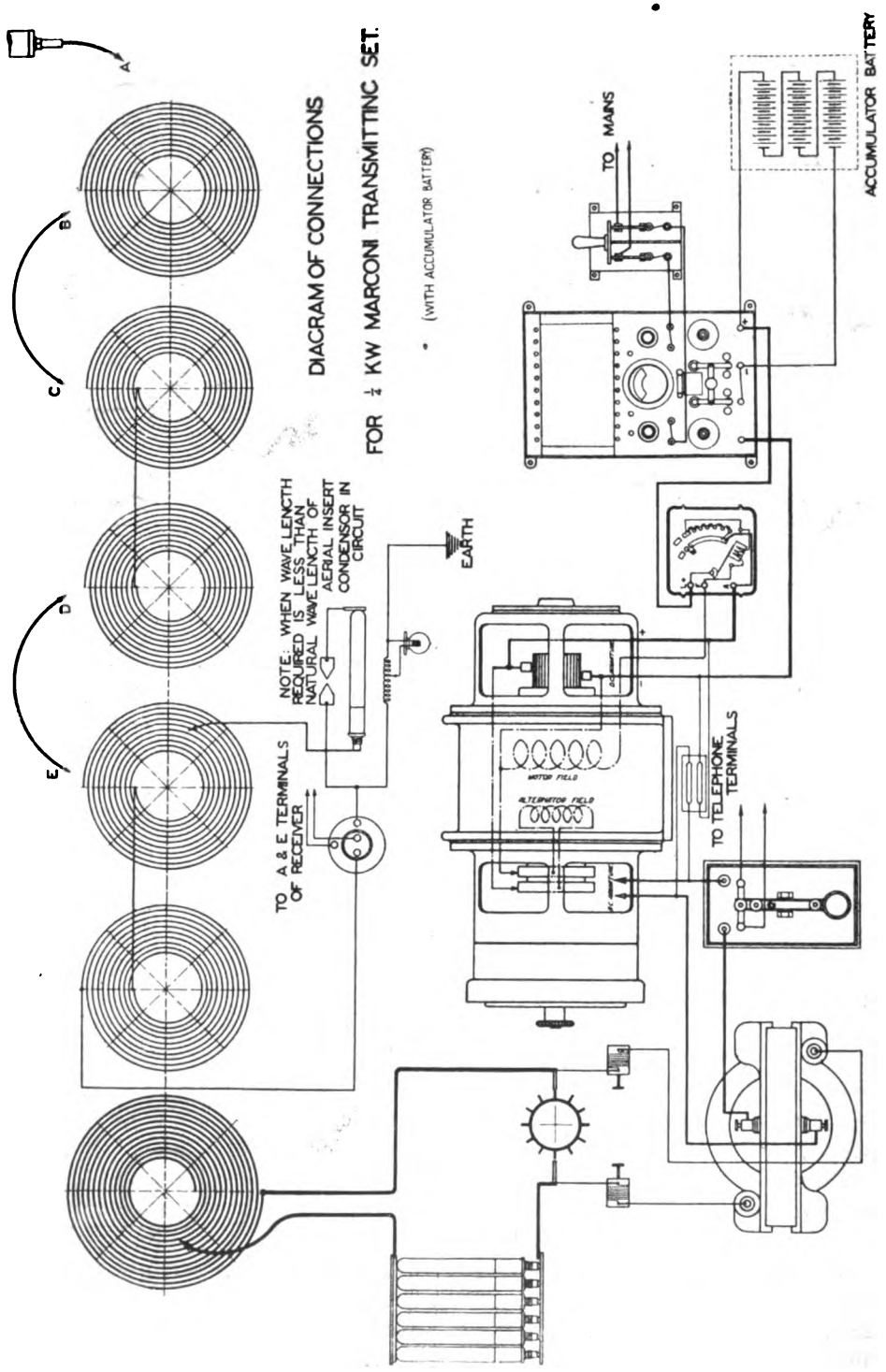

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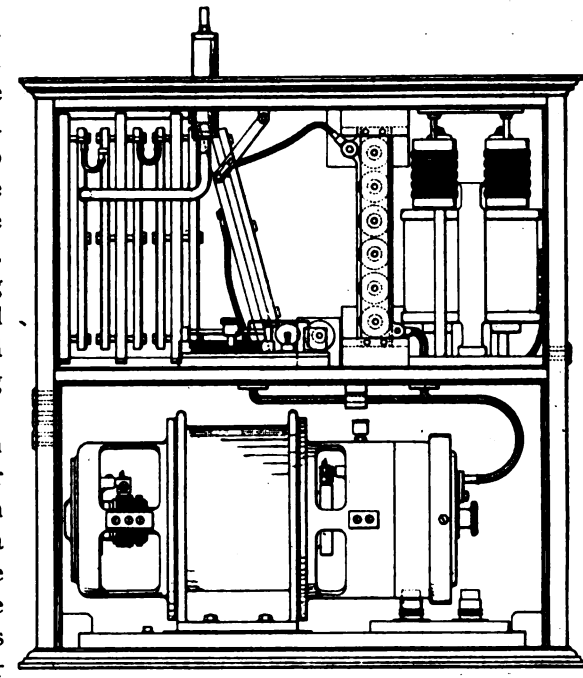
The secondary inductance consists of a number of flat spiral units, the various sections being connected up by means of flexible connectors stretching between one unit and another. A sufficient amount of aerial tuning inductance is provided to allow of the normal ship's aerial being tuned to the maximum wave-length without the need of external inductance.

The primary is hinged to the body of the cabinet and placed in front of the secondary winding, being fitted so as to swing outwards and allow of variation in the magnetic coupling between the primary and secondary circuits.

The manipulating key consists of a standard Marconi type wireless telegraph key, fitted with telephone short circuiting contacts on the back stops, serving to protect the telephones from strong induced currents while transmitting, and rendering it possible for the operator to listen in for the communicating station between intervals of transmission.

The accumulator batteries are contained in a cupboard designed to accommodate 30 special ship type 80-ampere hour cells. The arrangement of the cells in three tiers, 10 cells per tier, is chosen, as it allows of the cupboard being made of such dimensions as will allow of the same being secured to the back or side of existing deck structures.

Special care has been taken to ensure a free circulation of air through the cupboard. When the cupboard is placed in a sheltered position between the decks it is usual to fit at the top or side of the cupboard as most convenient, a torpedo or other approved type of induced draught ventilator.



INTERIOR OF CABINET SHOWN DIAGRAMMATICALLY

The electrical connection between the accumulator battery and the battery charging switchboard situated in the Marconi cabin is made by means of insulated cable, run in screwed steel piping.

Our illustrations will give readers an excellent idea of the general arrangement of the set, whilst the diagram of connections on page 440 will sufficiently explain the wiring. When the ¼ kw. set is used on small vessels as the main installation, a receiver, of course, has to be fitted. This consists of one of the Marconi standard crystal receivers, having a range of reception covering all wave-lengths between the approximate limits of 200 and 2,500 metres.

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Digest of Wireless Literature

Wireless Signals and the Aurora.

The following letter, which appeared in our contemporary *Nature* recently, will be of interest both to operators and students generally.

"Regarding the magnetic storm and the auroral display of June 17th, 1915, " referred to by Professor Barnard and Father A. L. Cortie (see *Nature*, Vol. XCV., " pp. 450, 536, etc.), it may be of interest to place on record the following facts. " Independent reports presented by Mr. Tulloch, the meteorological observer, and " Mr. Henderson, the wireless operator, at Macquarie Island, lat. 55° S., each mention " the Aurora Australis of that date as the most brilliant noted in periods of one year " and two years respectively. It was also the only occasion in two years when it " was absolutely impossible to receive signals from any other station—even the " high-power plant at Awanui, near Auckland (New Zealand), which seldom failed " to make itself heard.

" Mr. Tulloch's reports for three days were as follows :—

" ' *June 16th*, 9 *p.m.*—Barometer (corrected) 28·460 in., temperature 37·4° F., " ' wind N.N.W., force 5 (Beaufort scale). Fierce gales in morning; fine clear night; " ' slight auroral glow in south.

" ' *June 17th*, 9 *p.m.*—Barometer 29·361 in., temperature 27·0° F., wind S.W., 7. " ' Snowstorms continued throughout the day: three inches of snow on the ground. " ' Squally S.W. winds and high seas. Barometer rising rapidly.

" ' Brilliant red aurora. Looked something like a Japanese fan opening and " ' closing. Its centre or base was a little north of the zenith and spread out from " ' about E.S.E. to W.N.W. The colours varied from bright green and purple to a " ' deep red round the edges. The display continued all the evening, and at 10 p.m. " ' it worked to the N.N.W., appearing to reach the northern horizon.

" ' *June 18th*, 9 *p.m.*—Barometer 29·658 in., temperature 27·8° F., wind S.W., 9. " ' Snowstorms throughout the day with fierce S.W. gales. Brilliant aurora visible " ' between breaks in the clouds.'

" Mr. Henderson reports :—

" ' *June 16th*, 8.40 *p.m.*—Very pale glow low down to the south.

" ' *June 17th*, 5.30 *to* 5.40 *p.m.*—Very vivid blanket form of aurora in the zenith, " ' then a large red bank to the north-east very low and close, and red to the north " ' red fades and glow remains.

" ' 10 *p.m.*—Streamers and blanket form, and ring to the west and north.

" ' The " atmospherics " heard in the wireless receiver varied in strength from " ' 0 to 5 at intervals of about thirty minutes.

" ' *June 18th*, 9.20 *p.m.*—Sky nearly overcast, but bright glow visible overhead " ' for a few minutes.'

" Although the auroral and wireless data appear to lack correlation, it may " be of interest to note the circumstances under which the long and short waves " (2,000 m. and 600 m.) from Awanui, near Auckland, were received at Macquarie " Island

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" Of the six nights when both wave-lengths were recorded, the 600-metre wave " was much the stronger; on three nights when the aurora was reported the longer " wave-length was the stronger. On the remaining night the longer wave was again " the stronger, but the sky was overcast and the moon approaching the full. An " aurora, if there had been one, could scarcely have been seen in the circumstances.

" (Signed) H. A. HUNT

" (Commercial Meteorologist).

" Meteorological Bureau, Central Office,

" Melbourne, May 24th."

* * * * * *

A NEW TUNGSTEN-MOLYBDENUM ALLOY SUBSTITUTE FOR PLATINUM.

In view of the importance of platinum in wireless telegraphy, readers will be interested to hear that the discovery of a substitute was announced at a recent meeting of the American Institute of Mining Engineers in New York, by Dr. Frank Alfred Fahrenwald, of the Case School of Applied Science, Cleveland, Ohio. We are indebted to the *Electrical Experimenter* for the following particulars.

To appreciate fully how far-reaching is this discovery one has but to consider that platinum is now more than four times as costly as gold, being quoted early in March at between £17 and £18 an ounce.

A substitute for platinum has now been found in alloys of tungsten and molybdenum. These metals have, of course, long been known and used, but it has not hitherto been known how they could be made to resist oxidation.

Dr. Fahrenwald conducted experiments that led to the solution of this problem. Tungsten and Molybdenum possess many characteristics in common. The former melts at about 3,000 degrees C., the latter at 2,500 degrees C. They are practically insoluble in any of the common acids, their tensile strength exceeds that of steel, they can be drawn to finer threads than any other metals, while their specific gravity is 70 per cent. greater than lead. In recent years tungsten has been replacing platinum in the automobile industry. Their co-efficient of expansion is 30 per cent. lower than that of platinum.

The serious objections to them were that they oxidised easily at a red heat and that they would not readily solder with gold and its alloys. Moreover, the larger wires were quite brittle.

The present investigator discovered that tungsten and molybdenum emerged from a bath of molten gold with a beautiful impervious coating. This removed the objection of corroding, but the metal was still as brittle as glass. Dr. Fahrenwald then set to work to discover a way to overcome this, and tested at various temperatures and under various high pressures many combinations of tungsten, gold, molybdenum and palladium. He also devised a special electric furnace giving 3,000 degrees Centigrade. The inventor made tiny briquets of these blends by submitting finely divided powder to a pressure of more than 300,000 pounds to the square inch. He placed these in the furnace and treated them to temperatures ranging from 500 degrees to 2,800 degrees C.—the highest temperature ever used in treating a metal —for periods of from one minute to one hour, and hammered them while hot.

The best results were obtained with pure tungsten molybdenum, heated to 2,300

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degrees C., for one minute, the crystals being fine and the ingot quite homogeneous. These were forged without difficulty. An alloy of tungsten and molybdenum half and half was produced in wrought form that gave excellent results.

Dr. Fahrenwald summed up the work by saying :—" Except in two respects, " pure ductile tungsten and, to a lesser degree, molybdenum, meet all of the specifica- " tions of a practical substitute for platinum and its alloys. These two defects are " its ease of oxidation and the difficulty with which it can be soldered, and they have " been overcome by coating with a precious metal or alloy, the resulting material " being in many ways far superior to platinum or its alloys."

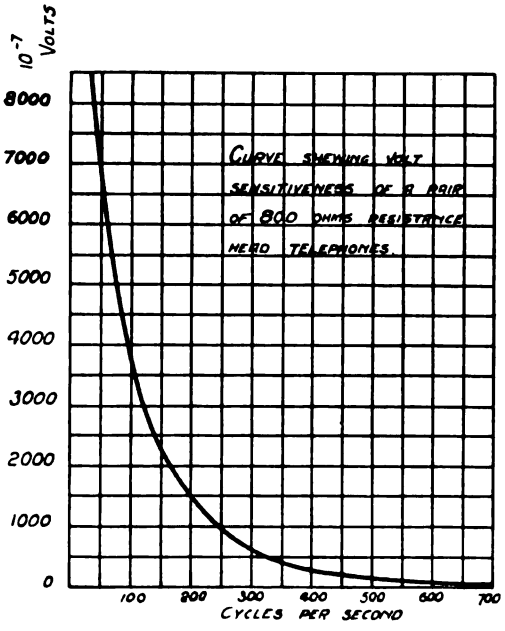
Tungsten and molybdenum are not nearly so expensive as platinum. The former was quoted in December at £600 a ton for 60 per cent. ore. It is now even higher. Molybdenum ore, which was £150 a ton before the war, was quoted in February at £720. These metals are necessary to the making of high speed tool steel, as they prevent it from losing its temper even when red hot. They are also in great demand by makers of artillery and ammunition. Prospectors are hungrily seeking deposits of tungsten ore. The world's largest deposit of molybdenum is said to be located at Catherine Hill, in Hancock County, Me.

* * * * * *

High Spark Frequency in Radio-Telegraphy.

An article in a recent number of the *Electrical Experimenter* by P. G. M. Clute contains some interesting details regarding high spark frequency.

It is certainly remarkable, says the writer, in the light of recent researches to increase the working range of radio-telegraphy that so little attention has been paid to the advantage of high spark frequency. One apparent cause of this neglect is the unfounded, though widespread, belief that the newer and recent types of high-resistance telephones such as are generally employed do not exhibit any great change of sensitiveness with variations in the frequency.



A great number of scientific observers, among whom are Wein and Lord Rayleigh, have noted that the telephone is more sensitive for high than for low frequencies.

With these investigations in mind, the U.S. Bureau of Standards has carried out a similar investigation on telephones of the type now used in radio-telegraphy. For the purpose a pair of head telephones of about 800-ohms resistance was taken. The Bureau has a set of dynamos in its laboratory ranging in frequency from 60–900 cycles per second and giving nearly pure sine waves, as free from overtones as possible. A current of from 80 to 100 milli-ampères was

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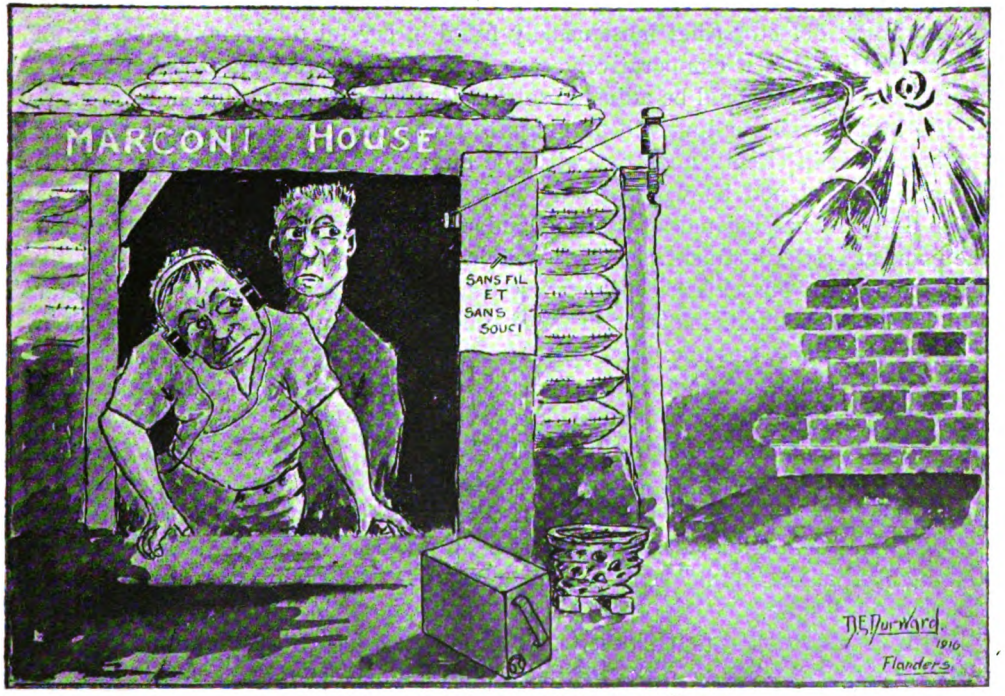
measured on a very sensitive hot-wire instrument and was then shunted through non-inductive shunts so as to cause sufficiently small fall of potential over a slide wire of known resistance; from this the requisite E.M.F. to just produce an audible sound in the telephone was taken.

Curve 1 gives the graphical representation of these results, and it will be seen that between 60 to 900 cycles the change in volt sensitiveness is over one thousand times.

If we consider these results in their bearing on radio-telegraphy, it appears that by increasing the spark frequency at the sending station we can increase many hundred times the effective sensitiveness of the receiving station. An additional advantage is pointed out in utilising a high-pitched musical spark, in that the ear picks out such signals with ease in the midst of ordinary interference and atmospheric disturbances.

Another distinct advantage is gained by spreading a given amount of energy over several sparks instead of concentrating it into one, in that the potential differences are reduced, resulting in a reduction of condenser losses, which in the average radio station amount to a considerable part of the total power.

Oh! that Aerial!



"THERE IT GOES AGAIN, BILL."

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Notes on Crystal Receivers.

An operator coming for the first time to a crystal receiver, after experience with the magnetic detector and multiple tuner, will find many points of difference, and many little practical details to be studied before he is able to get the best out of the instrument. He will realise that he is now confronted with a receiver in which the adjustment of the detector, as well as of the tuner, requires his careful attention when best results are to be obtained. Directly he comes on watch the operator should adjust the crystal of his receiver to the greatest sensitiveness, using for this purpose the testing buzzer. The buzzer itself must always be kept in good order, and is in its most useful condition when it gives a clean, musical note. With the carborundum detector (that most usually fitted in crystal receivers) the setting of the crystal itself is a comparatively easy matter. The steel plate which presses against the crystal should be adjusted so that the pressure is firm but not too hard, or the brittle carborundum will be likely to break off. He should next see that the battery is in circuit, and then with the buzzer-key depressed the slider of the potentiometer should be varied until the best signals are heard. Care must be taken that the buzzer signals are not too loud, otherwise it will be difficult to ascertain the point of best adjustment. It is as well occasionally to move the crystal slightly in its holder, the buzzer key being depressed meanwhile, as in some positions better signals are obtained than in others. This must be done with great care as carborundum is extremely brittle, and many crystals have been spoiled by careless handling.

Another important fact with which the operator is faced is that there is no "std-bi" position of the kind that is obtained with the multiple tuner and magnetic detector. The crystal, being a "potential" detector, must needs be placed in a separate circuit in which the pressure has been stepped up, and not in series with the aerial, so that the "std-bi" position of a crystal receiver is really a "tune" position with very tight fixed coupling, but no intermediate circuit. This is important to remember, as the "billi" condenser must be adjusted for best results on "std-bi" as well as on "tune."

It will be noticed that much looser coupling is obtainable with the crystal receiver, with a consequent increase in the sharpness of tuning. This valuable feature should be used to the full for eliminating and reducing interference.

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"Synchronous Signalling in Navigation"*

A STUDY of the causes of shipwreck immediately reveals the fact that the great majority of these disasters owe their origin to fog and the difficulties of navigation occasioned thereby. Any contribution to the science of signalling which may serve to reduce the risks of the mariner who has the misfortune to encounter these adverse atmospheric conditions will therefore be welcomed by all interested in navigation. The purpose of Professor Joly's book is to explain a system of his own devising by which the difference in speed of propagation between sound, light and wireless signals is turned to use for the estimation of position of a ship at sea.

The discovery of a speed of propagation of sound signals dates from 1827, when Colladon and Sturm carried out experiments on the Lake of Geneva. Students of physics will be familiar with these experiments, which consisted in transmitting from a boat moored on the lake simultaneous light and sound signals to an observer in a second boat at a distance. The sound signals were transmitted from a submerged bell suspended from the first boat, and the light signals by the ignition of a charge of gunpowder, the ignition apparatus and the hammer of the bell being mechanically connected. By observing the interval elapsing between the flash and arrival of the sound of the bell through the water, a determination of the speed of sound transmission in water became possible. In experiments over comparatively short distances such as were here dealt with, the time taken for the light flash to travel between the two boats is quite negligible. The interval of time elapsing between the sight of the flash and the reception of the sound signal gives an accurate indication of the speed with which sound travels in water—namely, 4,700 feet per second.

Sound in air, however, travels at a much slower speed, the distance traversed in one second being but 1,100 feet. If now a signal station on the shore be made to send out two simultaneously emitted signals, one, say, in air and the other in water, a ship off the coast receiving these signals can determine her distance from the station by noticing the interval or lag between the arrival of the faster-moving signal and the slower-moving signal. The accuracy with which the distance is determined will, of course, depend upon the observer and the methods he adopts for including the time interval between the signals. Experience at races has shown that it is possible to make time estimations with an error not greater than a fifth of a second, so that by observing the time lag of the slower signal (when dealing with signals in air and signals in water) the observer would be able to estimate his distance within a few hundred feet. However, the transmission of aerially-borne sound signals in fog is erratic and unreliable, and the use of submarine sound signals and wireless would be far more practicable. With this combination we are able to estimate distance within 1,000 feet, the larger margin of error being due to

* *Synchronous Signalling in Navigation*, by J. Joly, M.A., D.Sc., F.R.S. (London: T. Fisher Unwin, Ltd. 2s. 6d. net.)

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the smaller time lag between the submarine signal and wireless compared with the aerially-borne sound signal and the under-water signal.

Of course, the success of a system such as this depends largely upon the accuracy of timing by the observing officer. A chronograph is an easily operated instrument, and the interval between the receipt of signals may be timed, just as we time the interval between the arrival of the competitors in a race. A source of error which will occur to many readers is that due to the " personal equation " ; this, however, is not so great as would appear. Writing on this point, Professor Joly says : " It " is important to note that the degree of accuracy attainable in the readings is " enhanced by the fact that the errors of ' personal equation ' must be all of the " one sign and hence tend to cancel in the successive observations which go to each " determination. The observer necessarily in every case first hears the signal " and then makes the record. The delay (which constitutes the personal equation) " between receipt of the signal and the making of the record tends to be the same " for the receipt of the faster and slow-moving signals. But it is the *difference* " in time between the record of the one and the other which matters. Hence the " error is more or less eliminated."

The need for a chronograph may be eliminated by a system of sending out the faster of the two signals at such accurately timed intervals as will allow them to take the place of the time-measuring instruments on board ship. Thus if we arrange to emit thirty successive repetitions of the faster signals timed to intervals of one second, the arrival of the slower-moving signals can be timed by noticing how many of the " second " signals have been received beforehand.

An advantage of Professor Joly's system is that not only can the distance from a given point be ascertained, but also its bearing. For this latter purpose it is necessary to make at least two observations. Quoting Professor Joly again : " In this case the sailor draws a line on a piece of paper representing his own course. " He places a mark on the line representing his position when he heard the signal, " and from this point he describes a circle to the radius of five miles or whatever " the distance was. He now awaits another signal. When it comes he gets a new " distance—four miles—and he makes a second mark on the line at a distance " from the first mark corresponding to his run in the interval between the signals, " and, always to the same scale of distance, he strikes from the second point a circle " to the radius of four miles. This circle in general intercepts the first circle at " two points. The signal station is at one or other of these two points." In nine cases out of ten the problem is completely solved by this information, but if necessary a third observation will determine at which of these points the station is situated.

One section of the volume is devoted to the consideration of how collisions may be avoided, and here the author describes an instrument of his devising which he calls a Collision Predictor. This is really a calculator with scales (to be set in accordance with the observations) which shows at once whether collision is likely to occur, and if so the direction in which it is threatened.

The whole system of synchronous signalling as elaborated and described by Professor Joly is most ingenious and interesting, but the extent to which it will

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compete with the purely " Wireless " Direction Finder invented by Bellini and Tosi and perfected by the Marconi Company is open to question. Those who are acquainted with the latter invention will be aware that it can be used for ascertaining distance as well as direction by means of two observations and simple triangulation. It also has the advantage that but one set of signals is required and these need not be timed in any way. As this is not the place for the discussion of the relative merits of the two systems, we will leave readers to make the interesting comparisons for themselves.

The whole volume is most readably written, and the author is to be congratulated upon his lucid and full explanations of the various points which have to be considered. We are surprised that Professor Joly is apparently in ignorance of what has been done in purely " wireless " direction finding, for he says on page 30. " hitherto, when sights of the coast were not available, *to soundings alone* could " the mariner turn for help when the safety of his ship required the determination " of his position on the chart." (The italics are ours.)

In view of the author's extensive acquaintance with the subject, one would not expect to find, as is frequently the case, the misuse of the word " knot " in such phrases as " a distance of four knots." A " knot " is not a distance but a measure of *speed* meaning a nautical mile *per hour*, so that the statement " distance of four " knots " means a distance of four nautical miles per hour !

The book is excellently produced and can be recommended to all who are interested in the problems of navigation and the lessening of the dangers to which the mariner is exposed.

Edification Section

CONDUCTED BY OUR IRRESPONSIBLE EXPERT.

Now, what about you amateurs and all the stuff you read. D'you merely read the funny parts and slowly run to seed ? Or do you study theory in the way you ought to do, preparing for the happy time when peace is really true ? Don't think that when the war is o'er and amateurs are free that you can bring your aerial out and tie it to a tree, performing all the fancy tricks that you were wont to play before the Government arrived to take the gear away. Oh, no, that's not the kind of thing the future has in store, so don't let idle thoughts like that delude you any more ! The Government will say to you : " Look here, my dear young man. If you want to fix your wireless now according to this plan, you've just to let us see you *know* how all the circuits run or else ther'll be an end to such as you who want the fun. Then you'll go into an office right in front of lots of nobs who'll elicit information from between your frantic sobs while you tell them blushing crimson that you haven't Bangay's Book and at Hawkhead's splendid treatise you just hadn't time to look. So contemplate with humbleness the error of your ways and think how application is the only thing that pays.

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Wireless Telegraphy In the War

Radio-telegraphy at Every Turn.

We have on many occasions referred to the fact that Wireless Telegraphy nowadays enters into so many spheres of operation, that there are few matters of public importance without a wireless side to them. It might have been thought that the burning question of Ireland, a political sore that has been kept open for all these weary years and which seemed lately in a fair way to be healed, would not be concerned with this ubiquitous science. Yet when we read the memorandum recently sent to Members of Parliament by the Navy League, we find the following sentence, which contains the gist of their "warning":

"Whatever sea power protects Ireland, a country that can never be inde-
"pendent of the strongest sea power in Europe, must control the telegraphs, the
"telephone system, the wireless system, the heliographs and semaphores, the
"petrol and the heavy oil fuel required by submarines."

We recently saw how, during the Sinn Fein rebellion, the insurgents took full advantage of the facilities afforded by radio-telegraphy, and issued their proclamation of an Irish Republic to the world through that medium. The picture, we believe an entirely fancy one, drawn by the Navy League of a possible hostile Ireland, acting in conjunction with a foreign enemy and in full possession of the wireless installations, constitutes a forecast of what must never be allowed to eventuate. Clifden, at present the most important commercial wireless long-distance station of supreme importance for handling United States traffic, would be a potent instrument of evil in the event of its falling under the control of enemy hands. Of course, the Navy League is not altogether the purely non-political body which it professes to be, and its manifesto is largely an excursion into the realms of fancy. But the fact that, in dealing with the subject, it finds itself obliged to give a prominent place to the consideration of wireless, constitutes a fresh tribute to the importance which radio-telegraphy plays in every department of modern national life.

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Wireless Direction of Artillery.

One of the most interesting developments in the awakening of our British Brynhildr by the Siegfried of War is the issue of cinematograph films calculated to arouse

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popular interest and sympathy in the doings of the British forces on land and at sea. One of the most significant of those recently issued shows some of the great British guns in action with their fire directed by wireless from aeroplanes. In THE WIRELESS WORLD we have often described the process, and here we have it pictorially illustrated. An observer sends a radio message for fire to be opened, this is then transmitted by telephone to the battery, and the guns begin to speak. The observer

Photo by] *[Newspaper Illustrations*

A FRENCH WIRELESS SECTION AT A BRITISH POST.

notices perhaps that the range has not been correctly calculated; sends fresh messages to put the matter straight; elevations are altered, until the shells fall true on the German position, and the observer congratulates the gunners with his wireless "O.K." But what a difference it would have made in neutral countries if only we had started earlier! A correspondent writing from Zurich the other day saw a Swiss audience so enthused by British films of this description that the manager of the cinematograph establishment felt himself obliged to allay the demonstration by substituting others for the more exciting rolls, which he had intended to put on, illustrating some of the exploits of the British Navy.

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NAVAL AIRMEN ASHORE.

We print two pictures, on the following page, illustrating scenes "somewhere" in England." Under official guidance we learn the advisability of leaving

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much to the imagination, and our readers can fill in the locality at their pleasure. The Royal Naval Air Service, as its name implies, forms a branch of the British Navy, although much of its work is done on terra firma. Of our two pictures, the one below depicts two operators hard at work listening to the messages conveyed to them through the medium of the aerial, one of whose masts stands at the end of the meadow. The same "crew" forms the subject of the top picture on this page: here, however, they are grouped at the bottom of one of the masts which they themselves have erected. Readers will notice that the complement carried by this British cruiser on dry ground consists of two operators and a motor driver. "Jack" ashore is as easily and unmistakably a seaman as "Jack"

Photo by [*L. T. Sanderson.*

Photo by [*L. T. Sanderson.*

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afloat, and the rollicking spirit of the sea which he carries about with him wherever he goes constitutes one of his most attractive characteristics.

* * * * * *

An Advertising Bluff.

A great deal more attention than the occasion warranted was attracted by the voyage of the German submarine *Deutschland* to the United States. As pointed out at the time, the crossing of the Atlantic had been effected by a number of British submarines many months previously. However, our German imitator got through, although as yet we do not know with certainty by what method. Some say that it was with the assistance and under the convoy of a falsely styled "neutral" supply ship; others that she did it fairly "on her own." However that may be, she got there; and one of the first things that the Captain did on his arrival was to refuse to seal his wireless apparatus in accordance with the United States regulations. The authorities at Washington, rather hastily from our point of view, recognised her status as that of a merchantman, and she has thus been enabled to make a prolonged stay; with the result that a fortnight after her arrival the United States authorities insisted upon the sealing of the wireless, and sent a radio inspector to superintend the operation. The German Commander will find his return journey less easy than his outward. All sorts of dramatic devices were attempted in order to create mystification as to the start. The U.S.A. authorities, not unnaturally suspicious of German violations of neutrality, refused to permit the captain to send wireless messages to Berlin via the Tuckerton station. The Kaiser, therefore, who is said to have received by wireless the report of her arrival, will have to "possess his "soul in patience" till she arrives — or is "reported lost."

Photo by] [*Topical.*

THE GERMAN COMMERCIAL SUBMARINE "DEUTSCHLAND" LYING IN HARBOUR AT BALTIMORE.

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War Notes

Not long ago the Press came out with an announcement to the effect that the Dutch General Headquarters Staff had issued a long *communiqué* stating that the Army of Holland is now thoroughly prepared and equipped for any possible war. We do not know, of course, whether there may have been any political idea in the issue to the public of those documents, but it certainly possessed interest from many points of view. From that of radio-telegraphy, we may note that amongst the important items specifically referred to is the organisation and formulation of automobile stations for wireless.

Dutch Field Wireless.

* * * * * *

We were rather amused to read a number of notes published a short while ago by the well-known sportsman Mr. F. G. Aflalo. This well-known writer, after talking on the various " Wireless Warnings " which he had received in the course of his voyages during the present war, gives a list of the number of his old sea " Homes from Home " which have suffered destruction at the hands of the German Sea Wolves. They number four, and Mr. Aflalo is at considerable pains to explain that it would be very unfair to look upon him as a " Jonah." To quote his own words, " I am " not, exactly ! "

Sport and Travel.

* * * * * *

A recent description of " A Battle Cruiser's rigging loft " is mainly devoted to an enumeration of the rigging which no longer finds a place on our men-of-war. The only " top hamper " which has been added (instead of subtracted) since Nelson's day consists of the wireless aerial, which is thus dealt with by the writer : " The web of steel which catches the pulses " of the wireless current needs careful fixing and tending by the " rigger, though its insulation and use is controlled by the electrician. . . . The " platform, which forms at once a look-out and the station for the searchlights, is " fixed at the top of a steel rod, above which a few more yards of steel lifts the wireless " web well clear of the ship."

Warship Aerials.

* * * * * *

It is very easy to make allegations, which, when investigated, prove to be totally unfounded in fact. It will be remembered that in the summer of 1914 a mutiny on a small scale occurred at Singapore, and a British journal published the statement to the effect that a prisoner in a detention camp there had been proved by the court to have a wireless installation in his bungalow and was sentenced to a term of imprisonment after the war for breaking parole. The newspaper added that this traitorous prisoner was asked to dinner by the Governor of the Colony. Sir Arthur Young, the official in question, instituted an enquiry, and was able to report that no prisoner was convicted or even tried by the court for having in his possession a wireless installation ; no prisoner had broken his parole, and none had been "invited to Government House to dinner or any other meal." We wonder how much unnecessary trouble and expense was expended in disproving this baseless assertion.

Baseless Allegations.

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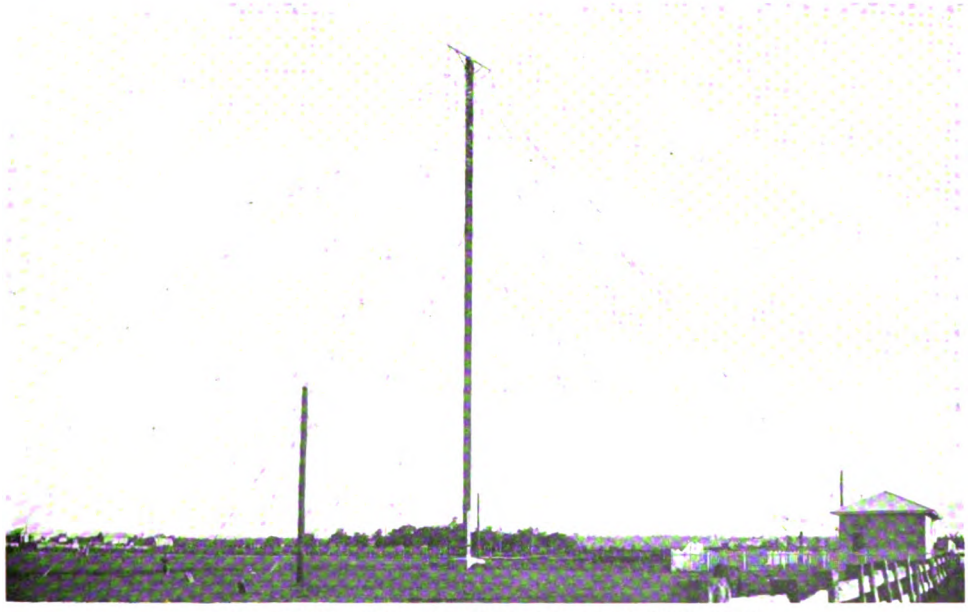
The Wireless Stations of Australasia

(FROM OUR AUSTRALIAN CORRESPONDENT.)

HAVING dealt in a previous number with the history of wireless telegraphy in Australasia, we think it will not be without interest to describe some of the radio-telegraph stations in that part of the world, thus supplementing the information already given.

The wireless telegraph stations in Australia, New Zealand, and surrounding islands are for the most part substantially low or medium power stations designed for ship and shore communication. Although those at present in existence have all been established in recent years, some time before the establishment of permanent stations was undertaken, two Marconi stations were erected for demonstration purposes, one at Point Lonsdale, near Melbourne, and close to the entrance to Port Phillip, the other near Devonport, on the northern coast of Tasmania. These stations were erected by the Marconi Company and will always be remembered as the earliest stations to work in that part of the world. Development, however, was not rapid and those stations remained unused for several years. For the information of the technical reader, we may say that they consisted of an earlier type of Marconi 1½ kilowatt station, and their main features included a Campbell 6-h.p. oil-engine, driving a 1½ kilowatt a.c. generator, which supplied current at 60 cycles frequency to an oil-cooled transformer. A bank of Poldhu-type condensers was charged from the secondary circuit of the transformer : the



THE MAST AND AERIALS OF THE WIRELESS TELEGRAPH STATION AT BRISBANE, QUEENSLAND.

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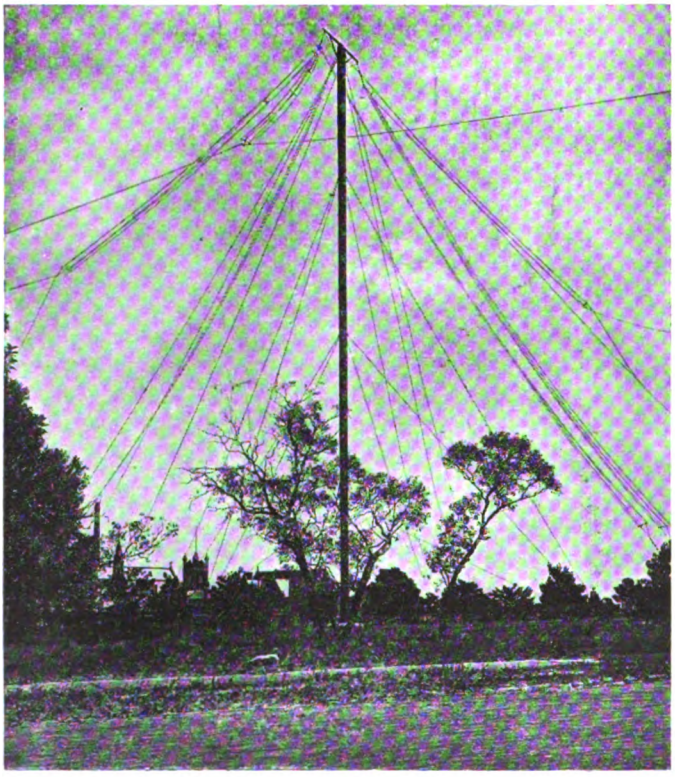
condensers discharged across a fixed spark gap through the primary of an oil-immersed oscillation transformer, the secondary of which was connected to the aerial, and to earth. The receiving apparatus included a Marconi coherer receiver and a Marconi magnetic detector. The aerials were slung between two masts at a height of about 180 ft. above the ground. The apparatus used was British-made throughout.

For many years the masts at Point Lonsdale formed a landmark for mariners entering Port Phillip, and the fact of their disappearance in the year 1912 was immediately noted by captains of Australian ships.

Both stations have now been removed, and no better tribute could be paid to British workmanship than exists in the fact that—after standing idle and unattended for several years—this apparatus was found in excellent condition, and some of it is actually in use at the present day at two stations within the tropics.

Before the year 1910, wireless communication in Australasia was practically confined to H.M. warships. An occasional mail steamer arrived with a Marconi equipment, but the P. & O. and Orient Lines initiated its application to regular trading vessels in 1910 and 1911. At that time there were no shore stations for communicating with ships, but the Marconi Company arranged a regular service of watches for vessels lying in port to provide communication with vessels approaching and leaving the Australian coast. This proved so successful that ships lying at Circular Quay in Sydney exchanged messages with vessels out in the Australian Bight, over 800 miles distant. Numerous official and private messages were received in this way at the several ports and handed in at the local telegraph offices for transmission to their destination.



GENERAL VIEW OF THE ANTENNA AT THE MELBOURNE RADIO STATION TAKEN FROM THE NORTH-NORTH-EAST.

The first commercial shore stations were erected in the Fiji Islands by the Marconi Company. These comprised a five-kilowatt plant at Suva and 1½-kilowatt stations at Labasa and Taviun

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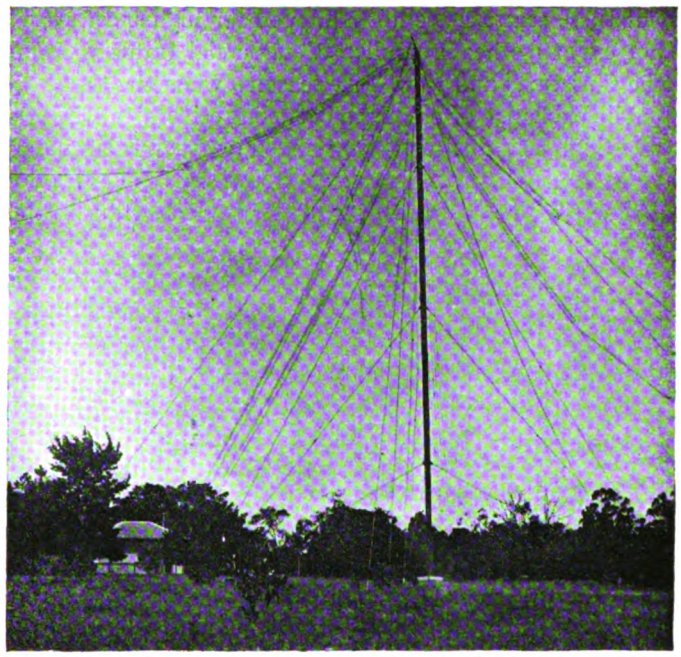
respectively: they were opened for traffic in 1911. Shortly afterwards a small temporary station for communication with ships at sea was erected at the Hotel Australia, in Sydney, and a similar temporary station on the General Post Office in Wellington.



VIEW OF MELBOURNE WIRELESS STATION AERIALS TAKEN FROM THE WEST.

From that time steady progress was made up to the outbreak of the great world war, when there were seventeen low power and two medium power stations in Australia, two low power and two medium power stations in New Zealand, and low power stations in Fiji, at Chatham and Macquarie Islands, and in British New Guinea. In Australia, stations for ship-to-shore communication exist in the vicinity of the chief port of each State—viz., Melbourne, Sydney, Perth, Adelaide, Brisbane, and Hobart, and intermediate stations are in operation at other points round the coast of the island continent. These stations have a normal range of 300 to 450 miles.

The New Zealand stations are situated at Awanui, near Doubtless Bay, in the extreme north, at Awarua, near Invercargill, in the extreme south, on the Post Office Building at Auckland, and on Tinakori Hills near Wellington. This system will probably be supplemented in the near future by the erection of low power stations at important points, such as Hawkes Bay, Christchurch (or Lyttelton), and Westport. The New Zealand low power stations possess slightly less power than the Australian stations, and their normal daylight range for communicating with ships is about 300 miles.

In addition to its chain of coastal stations the Australian Government has opened stations at Port Moresby in New Guinea and at Thursday Island. The New Zealand Government also operates the small station on Chatham Island, and until the present year both Governments operated conjointly the station on Macquarie Island, which was orginally erected by the Mawson Antarctic Expedition. All these stations are chiefly designed and used for communication with ships at sea at distances up to 450 miles.

The medium power stations, however, have greater ranges available for special work, but this was seldom made use of in normal times. When working at full power direct communication can be maintained between Sydney and Awanui (N.Z.),

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but these stations are not equipped for high-speed working and consequently could not exchange heavy traffic. Commercial traffic was only passed between them at the Christmas and New Year seasons, when the Governments made a feature of the public exchange of greetings between residents of the two countries.

Commercial traffic is exchanged between Australia and New Guinea *via* Townsville, Thursday Island, and Port Moresby. This traffic is steadily increasing, and will probably lead to the use of automatic transmitting and receiving apparatus in the near future.

An interesting feature of wireless communication in Australasia is the exceptionally long range of communication obtainable during the hours of darkness. Merchant ships and low power shore stations communicate frequently at distances over two thousand miles, and distances of 1,500 miles are commonplace occurrences. This fact, which is entirely due to natural and not to human agency, leads to a certain amount of friendly rivalry between operators and others responsible for the various stations; it also tends to give the layman an erroneous idea that communication over long distances can be "maintained" by low power stations. For an explanation of this phenomenon we must await the compilation of much more data than is yet available, and a more complete investigation of long distance transmission phenomena.

Photo by] [Hall & Co., Sydney

EXHIBITION OF WIRELESS TELEGRAPH APPARATUS AT THE TRADE FAIR HELD AT SYDNEY IN OCTOBER, 1915.

Prior to August, 1914, much Teutonic energy was devoted to the erection of wireless telegraphic stations in the late German possessions in the Pacific Ocean. Long-range stations were erected in German Samoa, Caroline Islands, and New Guinea, all of which have since been captured by the Australian and New Zealand forces.

Not the least among the wireless developments in and around Australasia was the establishment of a station on the Antarctic continent by

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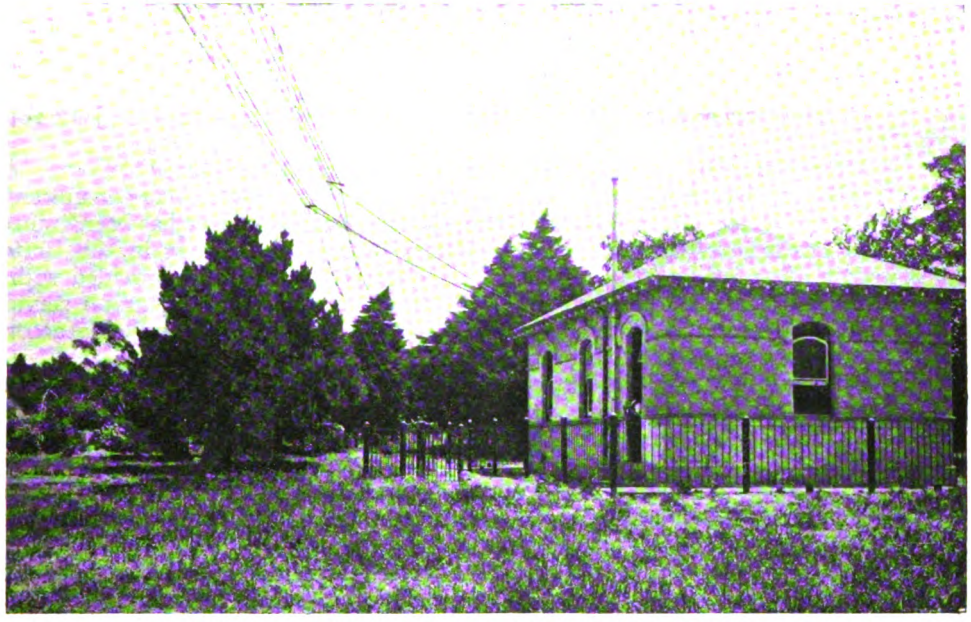

VIEW OF LOWER PORTION OF ANTENNA AT MELBOURNE WIRELESS STATION TAKEN FROM THE EAST.

Sir Douglas Mawson's expedition in 1912. This station, which was erected and manned by Australians who had been trained by the Australian Wireless Company, provided a link between the marooned explorers and the outer world for more than twelve months. Through it the adventures of Mawson and his comrades were made known to the world, the explorers received news of outside happenings almost daily through the long winter of darkness, and published a small journal entitled *The Blizzard*. The party also made regular meteorological observations which were transmitted daily to Australia and New Zealand. These wireless reports from the land of ice proved most valuable to the meteorologists of both countries. A startling illustration of the connection between Antarctic and Australian weather conditions was provided when on the day following a severe gale with heavy rains in New South Wales the newspapers published a message from Dr. Mawson in which he asked how Australians had enjoyed the rough weather he had "sent up."

All wireless land stations in Australasia are Government-owned. In Australia they are controlled by the Department of the Navy under the direction of Engineer-Lieutenant F. G. Cresswell. The New Zealand stations are controlled by the Post and Telegraph Department, and are chiefly superintended by Mr. T. Buckley, Chief Electrician for that Department. In Fiji the Superintendent of Telegraphs, Mr. C. C. F. Monckton, looks after the wireless service as well as the inland telegraph and telephone systems. These departments work in close co-operation with Amalgamated Wireless (Australasia), Limited, which owns the patent rights of the leading systems, operates all merchant ship stations, and manufactures wireless telegraphic apparatus for all purposes.

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Compulsory Wireless

THE following appeared in the *London Gazette* under the date of July 28th, 1916:

"After regulation 37A* the following regulation shall be inserted:

"37B (1) Every British ship of three thousand tons gross tonnage or upwards, "in respect of which a licence to instal wireless telegraph apparatus has been granted "by the Postmaster-General, and which puts to sea from a port in the United "Kingdom after a date to be specified in such a licence, shall be provided with a "wireless telegraph installation, and shall maintain a wireless telegraph service, "and shall be provided with a certified operator, together with suitable accom- "modation for the apparatus and operator:

"Provided that where a licence has been granted in respect of a ship before "the making of this regulation, this obligation shall apply as if the twenty-first "day of August, nineteen hundred and sixteen, were the date specified in the "licence.

"(2) Application to the Postmaster-General in a form prescribed by him for "such a licence shall, unless a licence has before the making of this regulation been "granted in respect of the ship, be made:

"(A) In the case of a ship of such tonnage as aforesaid, registered in the United "Kingdom, by the owner thereof on or before the twenty-first day of August, "nineteen hundred and sixteen; and

"(B) In the case of a British ship of such tonnage as aforesaid, registered "elsewhere than in the United Kingdom, by the master of the ship within two "days from the arrival of the ship in the United Kingdom next after the making "of this regulation.

"(3) The Postmaster-General shall, as and when wireless telegraph apparatus "and the service of operators become available for the purpose, cause licences to "be issued in respect of such ship as in the opinion of the Admiralty should in the "national interests be fitted with such apparatus, and the licences shall specify "the date as from which the carrying of such apparatus under this regulation is "to be compulsory, the character of the apparatus, and the qualifications of the "operator.

"(4) The Postmaster-General may

"(A) Extend the time mentioned in the licence as the time within which any "apparatus is to be provided; and

"(B) Exempt any ship from the obligations imposed by this regulation.

"(5) If the provisions of this regulation or the terms of any licence granted "thereunder are not complied with in the case of any ship, the master or owner "of the ship shall be guilty of a summary offence against these regulations, and if "any master or owner fails to make an application in accordance with this regulation "he shall be guilty of a summary offence against these regulations, and in either "case if the ship is at any time subsequently found at a port of or within the terri- "torial waters adjoining the United Kingdom the ship may be seized and detained.

"(6) In this regulation expressions have the same meaning as in the Merchant "Shipping Acts, 1894 to 1914."

The above regulation expresses in official language the fact that the owners of every vessel of 3,000 tons or over registered at a British port in the United Kingdom must take out a licence for a wireless installation before August 21st, 1916, irrespective

* A regulation providing that every British vessel of 500 tons burden or over shall be furnished with suitable hand flags for signalling by day, and efficient flash-lamps to carry three miles in clear weather for signalling by night.

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of whether it carries passengers or not. Moreover, the owners of any British vessel of other registration must apply for such a licence within two days of its arrival at a port in the United Kingdom. In order to meet the possibility that there might not be enough apparatus and operators to go round if all vessels at present unprovided were to be fitted at once, it will be seen that Clause 3 provides that the Admiralty should specify at what date vessels are to be fitted and that the dates so specified are to be inserted on the licences granted by the Postmaster-General. The latter has also the option of extending the time, or even of granting total exemption.

The " Safety of Life at Sea Convention " of 1912, to which the British Government gave their adhesion, has already embodied official recognition of the importance of wireless to ships at sea. A vast increase in the number of mercantile vessels equipped and in the shore stations opened for their benefit was the immediate result of its adoption. But up to the time of the outbreak of war it had not been found possible to carry out its provisions entirely, especially with regard to freight steamers, and it has been left for the stress of war to emphasise the equal necessity for freight steamers as well as passenger steamers to carry this all-important safeguarding equipment. Our enemies are straining every effort to prevent foodstuffs, supplies and other stores from reaching our island, and it is their action that has resulted in the British Government following the lead set them some time ago not only by the United States of America, but also by quite small republics like Uruguay.

An Automatic Electric Generating Plant for Emergency Use

MESSRS. R. A. LISTER & CO., LTD., of 47 Victoria Street, Westminster, have just placed on the market a highly interesting emergency generator with auxiliary apparatus under the title of the " SOS type, Lister-Bruston Patent Automatic Electric " Generating Plant," for use on board ship to supply current to the wireless and other apparatus when the ship's main dynamos are out of action. This plant contains a number of ingenious and useful features, some of which are the following :

(1) The auxiliary plant starts immediately the main supply fails.

(2) The plant is so designed that immediately the voltage of the ship's main supply falls below a predetermined point, the plant automatically starts up. On the other hand, the plant may be started by the operator or any other authorised person by pressing the push.

(3) It is self-regulating, adjusting itself to the load and maintaining a constant voltage.

(4) To ensure that the auxiliary plant is always kept in good working order, it is arranged that it shall automatically start up and stop at any predetermined time daily.

(5) Provision is made on the switchboard for charging in cells which may be required in connection with the apparatus.

For further particulars readers should apply to Messrs. Lister, at the abovenamed address.

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NOTES OF THE MONTH

WILL the Secretaries of all amateur societies which have not been suspended owing to the present war kindly forward full particulars of their societies to the Editor, in order that suitable notice may be inserted in the 1917 edition of the *Year Book of Wireless Telegraphy and Telephony*?

* * * * * *

The vagaries of public opinion are really remarkable! When Nature does not seem to be following her usual course all sorts of "explanations" are offered by those who know least about the subject. Thus, when the Marconi wireless station was established at Brow Head, the very wet summer season of that year was ascribed to the disturbance in the atmosphere caused by the emission of the ether waves. The latest assertion on these lines is that the bad weather of the current year is due to the altered direction of the Gulf Stream, which, it is now reported by captains, has turned westward.

* * * * * *

We would call the attention of our readers to the notice which appears on our contents page to the effect that many of the original drawings from which the illustrations in this and back numbers of our magazine are reproduced are for sale. We have been approached by several readers as to whether these drawings are available. Most of them are for sale, and if any reader desires one or more we shall be pleased to let him have any that are available.

* * * * * *

Our readers will recollect that, a year or two ago, a wireless installation was erected at St. Kilda, the lonely Atlantic island which lies many miles to the west of the Hebrides. Thus by this up-to-date method of communication the inhabitants of the island, who number seventy, have been receiving a constant supply of war news. It is interesting to note that there have been during the past year two births and three marriages in the island.

* * * * * *

We are glad to notice that, unless cause to the contrary be shown before October 14th next, the Anglo-German Wireless Syndicate is to be struck off the Register of Joint Stock Companies. The sooner all trace of any enemy influence is eliminated in this country the better.

* * * * * *

Among the members of the United British Industries Association we find the names of Marconi's Wireless Telegraph Company, Limited, and the Marconi International Marine Communication Co., Ltd. The Association has been formed amongst business concerns, in order that they may combine on a national basis to meet the competition of other countries after the war.

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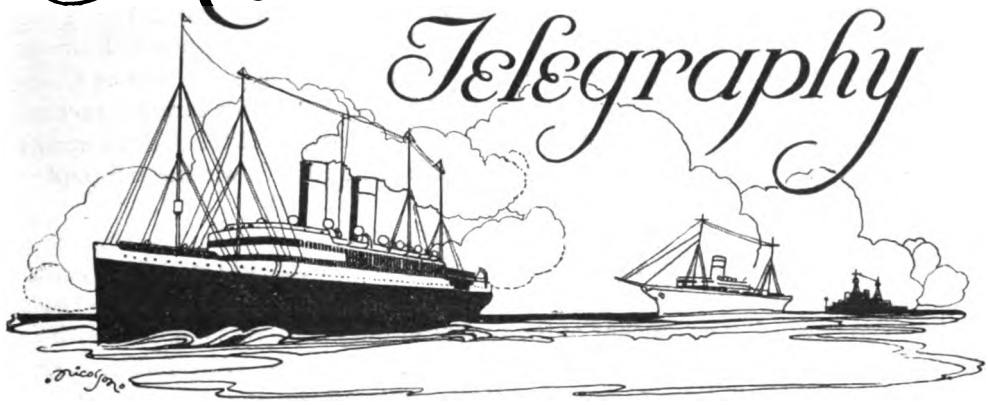
Maritime Wireless Telegraphy



Long-Distance Records.

Two further instances of long-distance records have recently been reported from the Pacific Ocean. The s.s. *China*, belonging to the China Mail Steamship Company, was in communication with the Marconi station at Hillcrest, California, from the day she left San Francisco until she was 2,800 miles away from that port. A similar occurrence was recorded by the steamship *J. A. Moffett* returning from the Orient to San Francisco. At 2,600 miles from that port, the night operator at Hillcrest picked her up. It is interesting to notice that both steamers are equipped with the new Marconi quenched-gap sets.

* * * * * *

A Disaster to the "Roanoke."

A sad tragedy of the sea recently and dramatically came to light. One morning a small ship's boat arrived at San Luis Obispo containing three men, the only survivors of the steamship *Roanoke*. She left San Francisco at midnight on May 8th bound for Valparaiso, and laden with a cargo of dynamite, wheat and oil. The next morning the *Roanoke* sighted a yacht, whose captain advised the *Roanoke* that a heavy sea was running, and that the wind was blowing at the rate of 20 miles an hour. Several wireless messages were received from the vessel after this, the last one giving her position as 90 miles south of San Francisco. From that time until the arrival of the small boat at San Luis Obispo nothing further was heard of her. Several statements have been made as to the way in which the vessel met her doom. The most reliable records that the ship began to list heavily several hours before she sank, and preparations were made to take to the lifeboats. Of these several were swamped with the heavy sea, and others caught in the davits as they were being lowered to the water. Immediately on the arrival of the small boat at San Luis Obispo, instructions were flashed by wireless from all the coast stations to ships at sea to search for additional boats and wreckage. This course, however, produced no result, so that we are reluctantly compelled to acknowledge that the whole of the crew met their death with the exception of the three men who made their way into San Luis Obispo.

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A New Steamer.

A new type of vessel has just arrived at New York from Italy. She is the new bulk cargo steamer *Milazzo*, belonging to the Navigazione Generale Italiana. She is of more than usual interest in view of the fact that she is the first of a new type of vessel, specially designed for the rapid handling of bulk cargoes, such as grain, coal, etc. Her gross registered tonnage is 11,477, whilst her dead-weight capacity is 14,240 tons. Needless to say the vessel is fitted with wireless telegraphy.

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A Youthful Scapegrace.

A sixteen-year-old adventurer of the United States recently had his dreams of a seafaring career cut short by wireless. For a long time it had been the boy's desire to go to sea, but on account of the European war his parents objected. Their consent, however, was given for him to take a cruise to the West Indies. The youngster shipped on the s.s. *Snowden Range*, but instead of going to southern waters his father learned that she was bound for Glasgow. He, therefore, sent a wireless to the captain, and the youth was taken off the ship at a subsequent port.

* * * * * *

Greek Steamer Founders.

The Cape Palos wireless station recently received a wireless message announcing the sinking of the Greek steamer *Nitsa*, which took place three miles north-east of Ormigas, in Spain. It transpires that she was torpedoed off Cape Palos, but fortunately the crew were saved by the Spanish steamer *Albal*.

* * * * * *

Naval Collier Sinks.

The United States naval collier *Hector*, bound from Newport News to Guantanamo, Cuba, sent a wireless message recently that she was aground and breaking up ten miles from Charleston. The tug *Vigilant* subsequently reported that the *Hector* had sunk, and that only the superstructure remained above water.

* * * * * *

A Dardanelles Occurrence.

There has just come to light knowledge of the fact that, whilst the capable band of doctors and ambulance workers were proceeding to Serbia to aid that typhus-stricken country, a wireless message was received by the steamer on which they were travelling urgently requesting them to proceed instead to Malta, where a large body of our own wounded from the Dardanelles was in dire need of surgical and medical aid. Needless to say the ship was immediately headed for the island, and the work done there by the little band was enthusiastically praised by the Governor.

* * * * * *

Passenger Steamer Sunk.

A wireless telegram was received at The Hague from the Zeeland Steamship Company's vessel *Koningin Wilhelmina* stating that she had struck a mine in the neighbourhood of the Noordhinder Lightship, and that she was sinking rapidly. No subsequent message was received from her, and, as we know, she quickly settled down and disappeared beneath the waves. No passengers' lives were lost, but unfortunately three members of the crew perished. The *Koningin Wilhelmina* was a paddle ship of 1,964 tons gross, and on the voyage in question had 41 passengers and a crew of 60 aboard.

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The Wireless Transmission of Photographs

By MARCUS J. MARTIN.

In a series of articles recently contributed to this journal * the writer, in the space at his disposal, endeavoured to give as comprehensive a description as possible of the various methods that have been worked out for the wireless transmission of photographs. It was, of course, impossible to deal exhaustively with the subject, and the present article has been prepared with the idea of supplying more detailed information upon a point that of necessity was insufficiently dealt with in the first instance.

No apology will therefore be offered for introducing into these pages matter that is not strictly related to wireless work, and while these articles have mainly been prepared for those who are, or who are thinking of, experimenting in radio-photography, yet it is hoped that the information they contain will prove of interest and help to all those who are engaged in other branches of experimental wireless work.

To those who intend seriously to tackle the problem of the electrical transmission of photographs, either by wireless or over metallic conductors, two sets of apparatus will be necessary—one at the transmitting and one at the receiving station. In the volume already referred to several types of machines are described, each suitable for the various methods of transmitting and receiving with which they are used. An improved machine, designed and used by the writer for experimental work in connection with photo-telegraphy, is briefly described on page 20 and illustrated in Figs. 10 and 10*a*.

As at present there are no machines of any description on the market, and as the necessary information regarding their construction is not easily obtainable, the writer has prepared a constructional article with full working drawings of his experimental machine, so that the would-be experimenter will have no difficulty in getting his machines made, or, if he possesses the necessary knowledge and skill, in building them himself. This article will shortly be published in the well-known journal *Work*.

In almost every photographic method of receiving that is described the Nernst lamp is invariably mentioned as the source of illumination. Since the advent of the high-voltage metal-filament lamps the Nernst lamp has fallen somewhat into disuse for commercial purposes, but it possesses certain characteristics that render it eminently suitable for the purpose under discussion. To those who are not familiar with the working of these lamps the following notes, together with the diagram Fig. 1, will help to explain matters.

* See THE WIRELESS WORLD, Nos. 22 to 28, 1915. These articles have since been amplified and published in book form, *The Wireless Transmission of Photographs*, 2s. 6d. net. The Wireless Press, Ltd.

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Nernst lamps are made in two sizes, the larger being intended for the same work as usually done by arc lamps and the smaller to replace incandescent lamps. The smaller type is made to fit into the ordinary bayonet lampholders. The principal parts of the smaller type of lamp, as shown in Fig. 1, are the filament, the heater, the resistance, and the automatic cut-out. The current enters at the positive terminal, passes through the heater M, and out through the negative terminal. The filament B, which consists of a short length of an infusible earth made of the oxides of several rare minerals, of which zirconia is one, is a non-conductor at first, but becomes a conductor upon being raised to a high temperature by means of the heater M. As soon as the filament becomes conductive the current then passes through the automatic cut-out H, and the armature D is attracted, thus breaking the heater circuit. The current then flows from the positive terminal through the cut-out H, resistance J, and filament B, and from thence out of the lamp. These lamps burn in air and emit a brilliant light of high actinic power, the intrinsic brilliancy (c.p./square inch) varying from 1,000 to 2,500, as compared with 1,000 to 1,200 for ordinary metal-filament lamps.

Either direct or alternating current can be used with these lamps, and with direct current the polarity must be strictly observed, and that the positive wire is connected to the positive and the negative wire to the negative terminal. Once the lamp has been correctly placed in its holder it is essential that it should not be turned, as a change in the direction of the current will rapidly destroy the filament. The burner is very fragile, and should never be handled except by the porcelain plate P.

Care must also be taken to see that the voltage required by the burner and resistance equals the voltage of the supply circuit, and that only parts of the same amperage are used together on the same lamp. No advantage is obtained by overrunning a Nernst lamp, this only shortening its life without increasing the light. Under normal conditions the average life of the burner is about 700 hours.

The efficiency of the Nernst lamp is fairly high, being only 1·45 to 1·75 watts per c.p. The light given is remarkably steady, and the lamps are adaptable for all voltages from 100 to 300. The chief advantage of the Nernst lamp from a photographic point of view lies in the fact that it produces abundantly the blue and violet rays which have the greatest chemical effect upon a photographic film. These rays are known as chemical, or actinic, rays, and are only slightly produced in some types of incandescent electric lamps. Carbon-filament lamps are very poor in this respect.

It must by no means be assumed that because a light is visually brilliant it is the best to use for purposes of photography; and this is a point over which many photographers stumble when using artificial light. Many lights, while excellent for illuminating purposes, have very low actinic powers, while others may have low illuminating but high actinic powers. A lamp giving a light yellowish in colour usually has low actinic power, while all those lamps giving a soft white light are generally found to be highly actinic.

In addition to the actinic value of the source of illumination, the photographic film used must be very carefully chosen, as the chemical inertia of the sensitised film plays an important part in the successful reproduction of the picture. The

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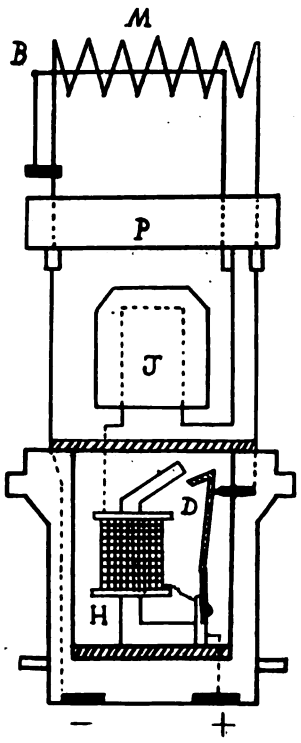
length of exposure, the amount of light admitted to the film, and the characteristics of the film itself are all factors which have a decided bearing upon the quality of the results obtained, and the film found to be the most suitable in one case will perhaps give very unsatisfactory results in another.

In photo-telegraphy the length of exposure is determined by the time taken by the transmitting stylus to trace over a conducting strip on the metal print, and this time, of course, varies with the density of the image and also with the speed of transmission.

The film in ordinary photography is chosen with regard to the subject and the existing light conditions, and the amount of light admitted to the film and the length of exposure are regulated accordingly. No such latitude is, however, possible in photo-telegraphy. With each set of apparatus the various factors, such as the light value, the amount of light admitted to the film, and the length of exposure will be practically fixed quantities, and the film that will give the most satisfactory results under these fixed conditions can only be found by the rough-and-ready method of "trial and error."

The films in common use are manufactured in four qualities—namely, ordinary, studio, rapid, and extra rapid. These terms should really relate to the light sensitiveness of the film (or, as it is termed technically, the speed), but at the best they are a rough and very unsatisfactory guide, for the reason that some unscrupulous makers, purely for business purposes, do not hesitate to label their films and plates as slow, rapid, etc., without troubling to make any tests for correct classification.

The speed of photographic films or plates is indicated by a number, and the system of standardisation adopted by the majority of makers in this country is that originated by Messrs. Hurter & Driffield, abbreviated H. & D. In their system the speed of the film and the exposure varies in geometrical proportion, a film marked H. & D. 50 requiring double the exposure of one marked H. & D. 100. The highest number always denotes the highest speed, and the exposure varies inversely with the speed.



Although theoretically the higher the speed of the film the less the duration of the exposure required, there is a practical limit, as besides the intensity and actinic value of the light admitted to the film a definite time is necessary for it to overcome the chemical inertia of the sensitised coating and produce a useful effect. With every make of film it is possible to give so short an exposure that although light does fall upon the film it does no work at all—in other words, we can say that there is a minimum amount of light action for every film, and anything below this is of no use. The exposure that enables the smallest amount of light action to take place is termed the limit of the smallest useful exposure.

There is also a maximum exposure in which the

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light affects practically all the silver in the film, and any increased light action has no increased effect. This is the limit of the greatest useful exposure.

In photo-telegraphy the duration of exposure, as already pointed out, is determined by certain conditions connected with the transmitting apparatus, and with conditions similar to those mentioned on page 75 the length of exposure will vary roughly from 1–50th to 1–150th of a second. The most suitable film to use would therefore be one in which these exposures come well within the limits of the film.

Another point, often puzzling to the beginner, and which increases the difficulty of choosing a suitable make of film, is that, although one make of film marked H. & D. 100 will give good results, another make, also marked H. & D. 100, will give very poor results. This is owing, not to a poor-quality film, as many suppose, but to the almost insurmountable difficulty of makers being able to employ exactly the same standard of light for testing purposes, so that although various makes may all be standardised by the H. & D. method, films bearing the same speed number may vary in their actual speed by as much as 30 to 50 per cent.

That make of film having the slowest permissible speed should be employed, as with the very high-speeded films there are greatly increased difficulties in connection with developing and handling.

The New Morse Code Card

THE new method of learning the Morse code, described and explained on the card entitled "Morse Made Easy," to which we made reference on page 300 of our July number, has evoked a considerable amount of interest, and is being welcomed in many quarters as by far the easiest method of memorising this useful code. Many students of signalling, wireless and otherwise, are using the new card for learning the code in odd moments, such as while travelling on the train, tube, 'bus and tram. Copies of the card can be obtained from the railway bookstalls and through the trade generally at the price of 3d., or 3½d. post free from the publishers, The Wireless Press, Ltd., Marconi House, Strand, W.C. Be sure to ask for "Morse Made Easy."

Manchester School of Technology

WE have just received the prospectus of the University courses in the Manchester Municipal School of Technology for the Session 1916–17. As usual, the up-to-date and progressive school authorities have arranged for the inclusion of a course of Wireless Telegraphy. The curriculum includes linear oscillators, directive radiation, measurements of current wave-length and frequency, spark frequency, logarithmic decrement, detectors, coherers, and valves. In fact, the subject is thoroughly expounded by that able professor, Mr. Bertram Hoyle, who, it will be remembered, contributed an article to our magazine last September.

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Among the Operators

AN interesting event in the world of wireless took place on July 14th, when Mr. Godfrey C. Isaacs, Managing Director of the Marconi International Marine Communication Co., Ltd., invited twenty-two Marconi operators to dine with him at the Trocadero Restaurant. The twenty-two were all men who had operated the wireless instruments under conditions of great peril, and in many respects the gathering was an unique one. Of course, all the heroes of the wireless service were not present, for many of them are at sea "carrying on" and helping to safeguard the mercantile marine; but all those who happened to be ashore at the time were able to attend, and made a brave array. The names of the guests and the ships on which they had served were as follows :—

HAROLD BRIDE (s.s. *Titanic*).

WALTER CONDON (s.s. *Minnehaha*, on which ship an explosion from bombs caused a fire).

OWEN CHICK (s.s. *San Melito*, which was bombarded by a German submarine and managed to escape).

PERCIVAL DENNISON (s.s. *Den of Crombie*, torpedoed by the Germans).

EDWARD DYER (H.M. transport *Royal Edward*, which was torpedoed in the Mediterranean).

F. L. FENN (s.s. *Harmatris*).

H. JONES (the ill-fated s.s. *Hesperian*).

R. JONES (the same vessel, and later the s.s. *Appam*).

JOHN KEIR (the transport *Royal Edward*).

R. A. C. LEE (the torpedoed *Vandyck*).

R. LEITH (s.s. *Lusitania*).

D. MCCORMICK (the same ship).

J. MAURICE (s.s. *Dakir*, which caught fire and was abandoned).

R. F. MCLENNAN (s.s. *Flamenco*, sunk by the German raider *Moewe*).

P. MORRIS (torpedoed *Iberian*).

H. H. MILLS (torpedoed *Anglo Columbian*).

R. C. OLDER (torpedoed s.s. *Goldmouth*).

J. R. OLIVER (torpedoed s.s. *Norseman*).

J. REA (s.s. *Anglo Californian*, shelled by a German submarine).

E. T. SHRIMPTON (the wrecked s.s. *Cobequid*, the s.s. *Kaipara* and the torpedoed s.s. *Drumcree*).

H. W. TAYLOR (torpedoed *Marquette*).

H. VARLEY (torpedoed *Simla*).

Fuller particulars of these men have already appeared in THE WIRELESS WORLD, but we would recall here that Mr. Dyer was so badly injured that his leg had to be amputated. He has not yet fully recovered. Mr. Older lost his foot owing to injuries received. Mr. Fenn received slight injuries to his leg and Mr. Shrimpton was wounded in the head. Mr. Keir was also badly bruised and cut. Some of the men have been appointed to positions ashore and others are still serving on the marine staff.

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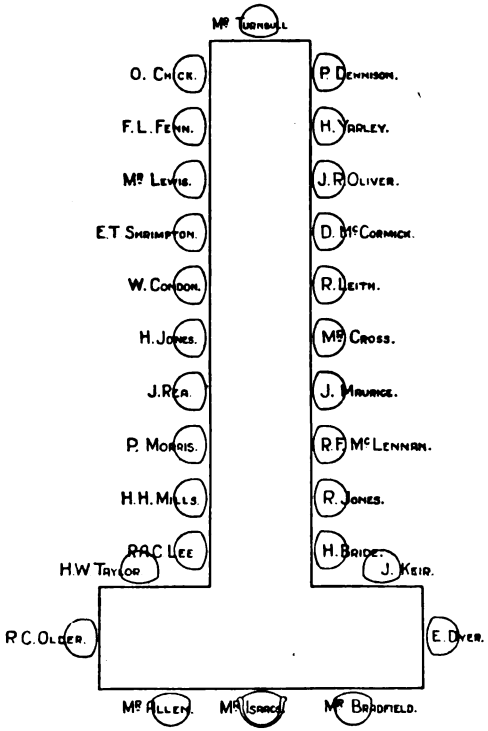

PLAN OF DINING TABLE.

Mr. Isaacs, presiding, spoke of his appreciation of the work performed and the pleasure he felt in dining with men who had so conspicuously upheld British traditions. On his right and left sat Mr. W. W. Bradfield, Manager of the Marconi International Marine Communication Co., Ltd., and Mr. H. W. Allen, the Secretary and Deputy Manager. Mr. G. E. Turnbull, Assistant Manager, and Mr. W. R. Cross and Mr. J. Lewis, Traffic Manager and Assistant Traffic Manager respectively, were also present, and did their utmost, very successfully, to make the evening an enjoyable one for the guests. Formal speeches were, of course, debarred, but among the toasts of the evening must be mentioned one by Mr. R. Jones to "Our Brothers on the Sea."

After dinner, the party proceeded to the Coliseum, occupying the Royal and adjacent boxes, to witness an excellent variety programme. The whole evening passed off most successfully and was but one more instance of the interest taken by the Marconi Company in the welfare of its employees.

* * * * * *

On page 463 readers will find reference to the disaster which overtook the United States steamer *Roanoke* off the Californian coast in May last. We regret to state that Operator George Ernest Chamberlain was amongst those who met his death. Like others in the service who have died in brave performance of their duties, he left behind him fine memories of courage and skill. Chamberlain was assigned to the *Roanoke* in April last, when she touched San Diego, California, on her last northbound voyage. None of the reports throw any light upon the way that Chamberlain met his death. The *Roanoke* was the first ship to which Chamberlain had been permanently appointed, although he had previously filled several temporary vacancies created by absence of the operators on holiday. Mr. Chamberlain was a native of Sawtelle, California, and after graduating from the Commercial School of that town, he attended the Polytechnic School in Los Angeles for a year. At this place he became greatly interested in electricity, especially in wireless, and soon installed a station in his own home. It is reported that he would often sit up all night sending and receiving messages from his little room, and listening to the workings of the wireless out on the Pacific Ocean. In October, 1914, he took his examination at the Y.M.C.A. at Los Angeles for wireless service and received his licence as an operator. Later he joined the Pacific Division of the Marconi Wireless Telegraph Company of America, and as we have above stated first filled a number

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of temporary appointments and then was assigned to the *Roanoke*. The late gentleman, who was but 20 years of age, was very popular in his home town, and his loss is deeply lamented by all who knew him.

OPERATOR SYDNEY GOODYEAR.

* * * * * *

S.S. "VIRGINIA."

Wireless operators in the mercantile marine are upholding the traditions of the Marconi Company so admirably that the recounting of their brave deeds is apt to become monotonous. One of the latest cases to come to our notice is that of the s.s. *Virginia*, on which Mr. S. Goodyear was in charge of the wireless apparatus. The following extract from a letter signed by the late Master of this ship and referring to Mr. Goodyear's services is, we think, worthy of reproduction here :—

"I always found him most attentive to his duties, steady, willing and obliging "at all times, and I have pleasure in testifying to the gallant manner in which he "stuck to his post, calling for assistance until the last moment after the vessel had "been torpedoed and was rapidly sinking."

Mr. Sydney Goodyear is 20 years old and was born in Lincolnshire. After leaving school he obtained employment on the telegraphic staff of the Great Northern Railway at Manchester. In April, 1915, he joined the London School of the Marconi Company and after a training at this place was appointed to the s.s. *Nevasa*. Later he was transferred to the *Virginia*, which was torpedoed in the middle of July of this year. He was fortunately rescued uninjured.

* * * * * *

CAPTURE OF THE S.S. "ESKIMO."

OPERATOR L. P. DE G. HUGO.

The capture of the Wilson liner *Eskimo* by the enemy will be well known to our readers through the notices which have appeared in the daily Press. The operator of this vessel, Mr. Leon Pierre de Graaff Hugo, who is related to the famous novelist, Victor Hugo, is of South African birth, belonging to an old Colonial family of Dutch descent. Mr. Hugo, who has lived for a number of years in England, completed his education at the Bedford Grammar School and West Ham Technical Institute. Before joining the Marconi Company he held a position in the Leytonstone Electricity Works. He received his preliminary Wireless training at the British School of Telegraphy and joined the Marconi Company's School in December,

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OPERATOR S. H. SANDERS.

1914. Since that time he has served on a number of ships and was appointed to the *Eskimo* in January of this year. We sincerely hope Mr. Hugo is being well treated.

* * * * * *

S.S. "ALTO."

The operator on board the mined steamer *Alto* was Mr. Stanley Harold Sanders, of Ilford. Mr. Sanders, who is 23 years of age, received his preliminary wireless training at the East London Telegraph Training College, Forest Gate, and entered the Marconi Company's School in October, 1914. He was first appointed to the s.s. *Glengorm Castle*, and from this ship was transferred to the s.s. *Minnehaha*. He then sailed on the s.s. *Karonga*, *Kumara* and *Wyncote*, and was appointed to the *Alto* in March of this year. Fortunately no lives were lost in the disaster, and Mr. Sanders escaped without injury and has since been able to resume his duties on another ship.

National Physical Laboratory

IN the Physics Department of the National Physical Laboratory at Teddington the electrical standards division has been largely occupied with the investigation for the Admiralty and the War Office of some special problems in connection with wireless telegraphy. In the division for general electrical measurements a number of special questions have been investigated, and at the same time it has been found possible to continue some of the research work, which has assumed increased importance during the war.

Dr. W. H. Eccles, A.R.C.S., M.I.E.E.

WE are informed that the Executive Committee of the City and Guilds of London Institute have appointed Mr. W. Eccles, D.Sc., A.R.C.S., M.I.E.E., to the Professorship of Electrical Engineering and Applied Physics at the Institute's Technical College, Finsbury, rendered vacant by the recent death of the late Professor Silvanus P. Thompson. Dr. Eccles is at present University Reader of Graphics at University College, and is the author of a work on *Wireless Telegraphy and Telephony*, and numerous papers and inventions on subjects connected with electrical engineering. We offer him our sincere congratulations.

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Wireless on the Captured "U.C. 5"

MANY professional wireless men and others interested in radio-telegraphy have paid a visit to the captured German submarine, which has been exhibited by the Admiralty at the Temple Pier, London. Although the vessel was severely damaged by the explosion which took place aboard just prior to her capture, the Admiralty have re-erected the aerial so that the public may see how the wires are arranged. The antenna, which is of the two-wire "T" type, is supported by the central mast, from which the flags can be seen suspended. A small spreader at the top holds the wires apart, the wires themselves being drawn down to the bow and stern. The arrangement of the wires and spreader forward of the mast can be well seen in the photograph, and the after wires, not so clearly shown, are arranged in a similar fashion. The down-lead to the deck insulator is taken from aft of the spreader, and is led to a flexible insulated cable, which in turn is connected to the lead-in tube. The short section of flexible cable and the lead-in tube can be seen on the bridge immediately behind the periscope. When not in use the mast, which is hinged at its base, folds down on to the after deck.

It will be seen that the aerial arrangements are neither so elaborate nor so interesting as those described and illustrated by Mr. Percival Dennison in our issue for February last. This is probably due to the fact that the *U.C.* 5 is one of the earlier types of German submarine.

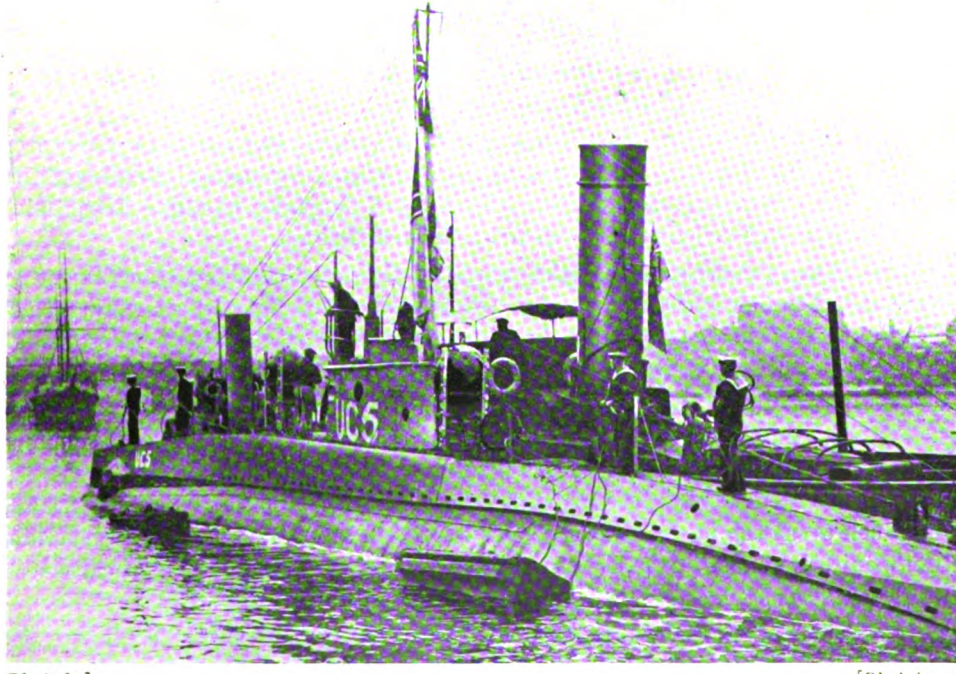

Photo by] [*Photopress.*

THE SUBMARINE MINE-LAYER BEING BERTHED AT TEMPLE PIER. H.M.S. "PRESIDENT" IN THE DISTANCE ON THE LEFT.

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Wireless Telegraphy in Newfoundland

THE following report was published in the June number of the *Monthly Proceedings of the Association of Chambers of Commerce of the United Kingdom.* It is embodied in the Report of the Meeting of the Executive Council, held on 20th June, 1916 :—

" TELEGRAPHIC COMMUNICATION WITH NEWFOUNDLAND.

" The Council had this subject under consideration, and the following copy of a " Petition presented by the St. John's Newfoundland Board of Trade to the Right " Honourable Sir Edward P. Morris, P.C., Kt., K.C., LL.D., Prime Minister of New- " foundland, was read :

" PETITION

" SHOWETH

" 1. That the Marconi Wireless Telegraph Company of Canada, Limited, " inaugurated in 1907 a Wireless Telegraph Service between Newfoundland, Canada " and Great Britain, introducing rates at a considerable reduction below those charged " by the Cable interests.

" 2. That the British and Canadian Governments, realising the benefits of the " cheap and efficient telegraph facilities rendered by the Marconi Service, recognise " the Marconi Company as an International Cable Company, and have placed it on " an equal footing with all other Cable Companies.

" 3. That the Newfoundland Government has refused to entertain the repeated " requests of the Marconi Company to be granted proper through rates and facilities " on the same terms as conceded to other Cable Companies handling Telegraphic " Traffic between Newfoundland, Canada and Great Britain.

" 4. That in consequence of the refusal of the Newfoundland Government to " extend to the Marconi Company facilities usually accorded to a connecting Tele- " graph Enterprise, the Marconi Company is compelled to accept messages at " ' Domestic Rates,' thereby operating at a serious disadvantage as compared with " the competitive Cable Companies.

" 5. That in view of the actual financial loss incurred by the Marconi Company " in handling Newfoundland traffic as a result of this unfair discrimination, it has " now been practically decided to withdraw the Marconi Service from the Island, " in which event the increased charges incurred by routing messages over the Cable " Companies' systems will cause hardships to your constituents and affect the overseas " trade of the Colony.

" 6. That the contract entered into by the Government with the Commercial " Cable Company, granting special privileges to that Company, expires on the 10th " May, 1916, and that the present is an opportune moment for the Government to " remove the discrimination against the Marconi Company.

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"7. Wherefore your petitioners humbly pray that the Government may be "pleased to sanction the passing of legislation:—

"(*a*) To recognise the Marconi Company as an International Cable Company "and to grant to it a 'through word rate' on all messages originating at or "destined for Newfoundland points on the same basis as the conjoint rates "rendered by the Newfoundland Postal Telegraphs, to the other competing "Cable Companies, and generally to confer upon the said Marconi Company "all the rights and privileges as the Cable Companies operating in the Island "at present enjoy.

"(*b*) To amend without delay the agreements now in force between the "Government and the Commercial Cable Company, dated 10th May, 1906, "and between the Government and the Marconi Company, dated 6th April, "1906, so that the Marconi Company shall be free to handle messages originating "outside the Colony and destined to Newfoundland points, and vice versa, by "means of its stations at Cape Ray or Cape Race and a connecting station on the "mainland of Canada.

"*1st May*, 1916.

"The Council unanimously decided to support this petition, and the following "resolution was passed for transmission to the proper quarters:

"WHEREAS a petition was presented by the Board of Trade, St. John's, New- "foundland, to the Premier and Legislature of the Colony on 1st May, 1916, praying "that the same and equal through rates and traffic facilities be accorded to the "Marconi Wireless Telegraph Company of Canada in respect of all messages "originating at and destined for places in Newfoundland as are granted generally to "other competing telegraphic interests, and

"WHEREAS the Association is informed that the Marconi Wireless Telegraph "Company of Canada has hitherto by reason of prohibitive rates carried messages "from Newfoundland at a loss, and finds it necessary to withdraw from telegraphic "business with the Colony, unless such through rates and traffic facilities are granted, "and

"WHEREAS representations have been made by merchants and Chambers of "Commerce in the United Kingdom in favour of the granting of such through rates "and traffic facilities and the encouragement of undertakings reducing telegraphic "charges,

"RESOLVED that this Council urges the Government of Newfoundland to grant "such through rates and traffic facilities to the Marconi Wireless Telegraph Company "of Canada, and generally to any other British telegraphic undertakings as are "granted to any other telegraphic undertakings in the Colony, and considers that "it is desirable from a commercial and imperial point of view that every step be "taken to secure reductions of telegraph rates and to enable the commercial com- "munity to avail themselves of Trans-Atlantic and other wireless services, and "expresses the hope that the petition of St. John's Newfoundland Board of Trade "may be acceded to. Copies of this resolution to be officially forwarded to the "Premier and Government of Newfoundland, the Colonial Office, and the St. John's "Newfoundland Board of Trade."

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Copies of this resolution were duly despatched to those enumerated, and on June 28th last the Premier of Newfoundland (Sir E. P. Morris) replied to Mr. R. B. Dunwoody, the energetic and courteous Secretary of the Association of Chambers of Commerce, as follows:

"*June 28th*, 1916.

"DEAR SIR,—I have to acknowledge the receipt of your communication of "June 27th covering copy of the resolutions unanimously adopted by your associa- "tion on the 20th instant. I shall take great pleasure in forwarding these to "Newfoundland for the consideration of the Government.

"I may say to you that the whole of the subject matter of the resolutions has "been for some time under the consideration of the Newfoundland Government, "and I have no doubt at a very early date a solution of the question satisfactory "to all concerned will be arrived at.

"Yours, etc.,
"E. P. MORRIS.

"R. B. Dunwoody, Esq."

It would therefore appear as if the disabilities from which the Marconi Wireless Telegraph Company of Canada has been suffering for so long a period will, in the near future, be removed.

The company, according to its usual custom, gave the merchants in Newfoundland the benefit of its cheaper Atlantic facilities, and they were thus able to exchange telegrams with their correspondents at 8d. per word for ordinary messages, 4d. per word for deferred plain language telegrams, 2s. 6d. for night letters of 13 words, and 2d. per word for each additional word beyond 13, and 4s. for week-end letters of 25 words, plus 2d. per word for each word beyond 25. The Government of Newfoundland, however, would not grant the company through rates and facilities, and all messages for transmission *via* Marconi were treated as local messages, which means that they had first to be sent as inland telegrams to the company's telegraphic address at a rate in excess of the total rate collected for transmission to London, leaving the company to pay out of their own pockets any loss incurred. This the company cheerfully did, hoping eventually to obtain proper facilities, but as no satisfaction could be obtained they were forced eventually to give notice of the withdrawal of the Marconi rates. This resulted in the strongly worded petition above referred to, and equally strong resolution of the Associated Chambers of Commerce, which do not leave any doubt of the attitude of the mercantile community of not only Newfoundland, but also of Great Britain.

It will be seen that the Association of Chambers of Commerce in their resolution take the question entirely out of the local atmosphere, and place it on an Imperial basis.

It may also be stated that the London Chamber of Commerce took independent action, and addressed various letters to Government Departments and to the St. John's Board of Trade, and the company has besides many letters from important firms showing their strong feeling in favour of the Marconi Company's transatlantic service, and their opinion that every support should be given to it. The settlement of the question now awaits the return of Sir Edward to St. John's.

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Foreign Notes

CANADA.

FROM news to hand from Canada it is learnt that the New Canadian Government Railway, which is to connect Hudson Bay with the Canadian Northern Railway at Le Pas, Manitoba, will be equipped with wireless telegraphy instead of the old wire system.

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FRANCE.

The city of Lyons, in France, has made a big step forward in regard to the problem of what to do with permanently disabled soldiers after the war. It has most enterprisingly started a professional school for the wounded. When the patient leaves the doctor's hands he is passed on to the school, and the instructor there sends him back into the world with a trade in his hands and new youth in his heart. Among the subjects taught are the manufacture of toys to compete with Germany, photography, clockmaking, bookmaking, and wireless telegraphy. The latter is due to the initiative of Dr. Vigne, the new chief of the medical staff.

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GERMANY.

From a Swedish source it has recently been intimated that wireless telegraph traffic has been reopened between the United States and Germany. It had been interrupted during the past month owing to atmospheric disturbances.

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HOLLAND.

It is understood that the Government of Holland is planning to establish direct wireless communication between that country and the Dutch East Indies, in order to supplement the present cable service.

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PACIFIC.

With the satisfactory conclusion of the official tests between the high-power wireless stations at Funabashi (Japan) and Honolulu, the Trans-Pacific scheme of wireless intercommunication is now complete. M. Tanaka, Director-General of Posts and Telegraphs in Japan, has despatched to Mr. E. J. Nally, the General Manager of the Marconi Wireless Telegraph Company of America, hearty congratulations upon the results of the final tests.

The Trans-Pacific wireless service, stretching across some 6,300 miles of ocean, will be conducted between Funabashi and San Francisco, the station at Honolulu acting as a relay. The section between San Francisco has been in operation for some months; the Honolulu-Funabashi section, which has just received official approval, spans an interval hundreds of miles greater than the distance between Berlin and New York. Descriptions of the Honolulu station have already appeared in our magazine.

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PORTUGAL.

According to reports from Portugal, a scheme is afoot for the inauguration of

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an extensive system of wireless telegraph stations to link Lisbon with the Portuguese colonies and other European capitals.

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SIBERIA.

The wireless station on Dickson Island was to have been dismantled, but, thanks to the timely and enlightened intervention of the Russian Naval Ministry, which is providing the necessary funds, its existence is saved, and it will be able to carry on work not only of great scientific value, but also of practical utility for Arctic navigation, which is just now of special importance for Russia. The island is at the mouth of the River Yenesei.

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UNITED STATES.

In view of the strained relations which unfortunately exist between the United States and Mexico, the former country has deemed it necessary to send out broadcast, wireless warnings to ships at sea to beware of lighthouses in Mexican waters, some of which have extinguished their usual lights. Others have been altered in order to hamper American naval operations.

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Prominent among the features of the parade of the New York Signal Corps as third line of defence for the American nation was the wireless cart of the 1st Battalion, which was offered as a gift by the Marconi Wireless Telegraph Company of America. On the sides of the cart appeared the words " 1st Battalion Signal Corps, Junior American Guard." The procession also contained more mobile units of light equipment—viz., wireless pack sets. These, which were carried by members of the Signal Corps, formed a subject of considerable interest and comment among the spectators. More than a thousand members of the National Amateur Wireless Association and the Guard were in line.

* * * * * *

News is to hand that members of the National Amateur Wireless Association are now in summer camp at Birchwood Lake. This sheet of water nestles among the ranges of the Shawngunk Mountains in Sullivan County, New York, 1,600 feet above the level of the sea. Its location is about 100 miles from New York City. The wireless station to be operated under the auspices of this Association will be set up on a knoll near the Lake, whilst a tall pine tree will probably be used as one of the supports for the antenna. A competent wireless telegraphist will be in charge of the station and will give instruction in the science. A number of pack sets will also be provided to supplement the work of the main station. The camp will remain open until September 9th.

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According to American newspapers it is said that a powerful Government wireless station at Yerba Buena Island, near San Francisco, has picked up radio messages emanating from Germany. Pacific Coast commercial stations have also received messages from Hanover, Germany, says the Marconi operator at Point Reyes. " This is unusual," he continues, " as our station is not tuned to work with the " German stations."

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Instructional Article

NEW SERIES (No. 13).

The following series, of which the article below forms the thirteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Partial Fractions.

88. The operation of summing a number of algebraical fractions is perfectly simple. For example, to find the sum of the two fractions $\frac{4}{7x-9}$ and $\frac{3}{5x+6}$ we proceed exactly as with arithmetical fractions:

$$\frac{4}{7x-9}+\frac{3}{5x+6}=\frac{4(5x+6)+3(7x-9)}{(7x-9)(5x+6)}$$

The denominator of this new fraction is the L.C.M. (in this case also the product) of the denominators of the previous fractions, and each part of the numerator consists of one of the previous numerators multiplied by the number of times its respective denominator divides into the new denominator.

Multiplying out we get

$$\frac{(20x+24)+(21x-27)}{(7x-9)(5x+6)}=\frac{41x-3}{(7x-9)(5x+6)}$$
$$=\frac{41x-3}{35x^2-3x-54}$$

89. We will now endeavour to carry out the reverse operation, splitting up this fraction $\frac{41x-3}{35x^2-3x-54}$ into its two simpler or *Partial Fractions.*

As a start we factorise the denominator into the two factors $(7x-9)$ and $(5x+6)$. Each of these will now become a denominator of one of the partial fractions. It now remains to find the two corresponding numerators, and we will call them, for the present, A and B respectively.

Thus we have

$$\frac{41x-3}{35x^2-3x-54}=\frac{41x-3}{(7x-9)(5x+6)}=\frac{A}{(7x-9)}+\frac{B}{(5x+6)}$$

We next multiply both sides of the equation by $(7x-9)(5x+6)$, in order to clear out all the fractions. We get

$$\frac{(41x-3)\{(7x-9)(5x+6)\}}{(7x-9)(5x+6)}=\frac{A\{(7x-9)(5x+6)\}}{(7x-9)}+\frac{B\{(7x-9)(5x+6)\}}{(5x+6)}$$

which cancels out to

$$(41x-3)=A(5x+6)+B(7x-9)$$

Now this equation will remain true, *whatever value we give to* x, and so let us put $x=\frac{9}{7}$ (you will see the reason for this shortly), and fill in this value all along the equation.

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Then
$$\left(41\times\frac{9}{7}-3\right)=A\left(5\times\frac{9}{7}+6\right)+B\left(7\times\frac{9}{7}-9\right)$$
$$\left(\frac{369}{7}-3\right)=A\left(\frac{45}{7}+6\right)+B(9-9)$$
$$\left(\frac{369}{7}-\frac{21}{7}\right)=A\left(\frac{45}{7}+\frac{42}{7}\right)+B(0)$$
$$\frac{348}{7}=A\left(\frac{87}{7}\right)$$
$$\text{or}\quad A=\frac{348}{7}\times\frac{7}{87}=\frac{348}{87}=4.$$

You will now see that the value $x=\frac{9}{7}$ was deliberately chosen so that the factor $(7x-9)$ would become zero, and we should thus, by getting rid of B, be enabled to find the value of A. In a similar manner we can put $x=-\frac{6}{5}$ (in order to get rid of A), and so find B.

Thus
$$\left\{41\times\left(-\frac{6}{5}\right)-3\right\}=A\left\{5\times\left(-\frac{6}{5}\right)+6\right\}+B\left\{7\times\left(-\frac{6}{5}\right)-9\right\}$$
$$\left(-\frac{240}{5}-\frac{15}{5}\right)=A(-6+6)+B\left(-\frac{42}{5}-\frac{45}{5}\right)$$
$$-\frac{261}{5}=A(0)+B\left(-\frac{87}{5}\right)$$

Thus
$$B=-\frac{261}{5}\times\left(-\frac{5}{87}\right)=\frac{261}{87}=3.$$

Now that we have found that $A=4$ and $B=3$, we know that
$$\frac{41x-3}{(7x-9)(5x+6)}=\frac{A}{(7x-9)}+\frac{B}{(5x+6)}$$
$$=\frac{4}{7x-9}+\frac{3}{5x+6}.\quad \textit{Ans.}$$

Example.

Resolve $\frac{x^2+2x+1}{(x+4)(x+3)(x-1)}$ into partial fractions.

As before $\frac{x^2+2x+1}{(x+4)(x+3)(x-1)}=\frac{A}{(x+4)}+\frac{B}{(x+3)}+\frac{C}{(x-1)}$.

Multiplying all along by $(x+4)(x+3)(x-1)$ we get
$$x^2+2x+1=A(x+3)(x-1)+B(x+4)(x-1)+C(x+4)(x+3).$$

(i.) Put $x=1$.

Then $(1+2+1)=A(1+3)(1-1)+B(1+4)(1-1)+C(1+4)(1+3)$

or $4=A(4)(0)+B(5)(0)+C(5)(4)$

$4=20C$

$C=\frac{4}{20}=\frac{1}{5}$.

(ii.) Put $x=-3$.

Then $(9-6+1)=A(-3+3)(-3-1)+B(-3+4)(-3-1)+C(-3+4)(-3+3)$

or $4=A(0)(-4)+B(1)(-4)+C(1)(0)$

$4=-4B$

$B=-1$

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(iii.) Put $x=-4$.

Then $(16-8+1)=A(-4+3)(-4-1)+B(-4+4)(-4-1)+C(-4+4)(-4+3)$

or $9=A(-1)(-5)+B(0)(-5)+C(0)(-1)$

$9=5A$

$A=\frac{9}{5}$.

Ans. $\frac{A}{(x+4)}+\frac{B}{(x+3)}+\frac{C}{(x-1)}=\frac{9}{5(x+4)}-\frac{1}{(x+3)}+\frac{1}{5(x-1)}$.

90. It does not always happen that the denominator can be resolved into factors of the first degree.

Example.

Resolve $\frac{2x-7}{(x^2+3x+7)(x-5)}$ into partial fractions.

In a case of this sort we set it out as follows:

$$\frac{2x-7}{(x^2+3x+7)(x-5)}=\frac{Ax+B}{(x^2+3x+7)}+\frac{C}{(x-5)}.$$

From this, as before, we get $2x-7=(Ax+B)(x-5)+C(x^2+3x+7)$

Put $x=5$, and then $(10-7)=(5A+B)(5-5)+C(25+15+7)$

$3=(5A+B)(0)+C(47)$

Therefore $C=\frac{3}{47}$.

Now there is no value of x which will enable us to find A and B, as we cannot separate them, and so we must adopt some other method to find these two values.

We have the equation

$$2x-7=(Ax+B)(x-5)+C(x^2+3x+7).$$

Multiplying out—

$$2x-7=(Ax^2-5Ax+Bx-5B)+(Cx^2+3Cx+7C)$$

Collecting terms $2x-7=(A+C)x^2+(B-5A+3C)x+(7C-5B)$.

Now, taking this equation as it stands, we know that the value of the coefficient of x^2 on the left-hand side must equal the value of the coefficient of x^2 on the right-hand side. Now the value on the left is zero, and on the right is $(A+C)$.

Therefore $0=A+C$

or $A=-C=-\frac{3}{47}$.

Similarly the coefficients of x on each side must also "balance," and so

$$2=(B-5A+3C)$$

$$=\left\{B-5\left(-\frac{3}{47}\right)+3\left(\frac{3}{47}\right)\right\}$$

$$=B+\frac{15}{47}+\frac{9}{47}=B+\frac{24}{47}.$$

Therefore $B=2-\frac{24}{47}=\frac{94}{47}-\frac{24}{47}$

$=\frac{70}{47}$ or $1\frac{23}{47}$.

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It would, in this case, have been simpler to have equated the *constant* terms. On the left-hand side we have -7, and on the right-hand side $(7C-5B)$.

Thus
$$-7=7C-5B$$
$$=7\times\frac{3}{47}-5B=\frac{21}{47}-5B$$
$$5B=\frac{21}{47}+7=\frac{21}{47}+\frac{329}{47}$$
$$=\frac{350}{47}$$
$$B=\frac{350}{5\times47}=\frac{70}{47}\text{ as before.}$$

Ans. $$\frac{Ax+B}{(x^2+3x+7)}+\frac{C}{(x-5)}=\frac{-\frac{3}{47}x+\frac{70}{47}}{(x^2+3x+7)}+\frac{\frac{3}{47}}{(x-5)}=\frac{70-3x}{47(x^2+3x+7)}+\frac{3}{47(x-5)}.$$

Example.

Resolve $\dfrac{3x^2+4x-2}{(x+1)^2(x-2)}$ into partial fractions.

In this case it is possible that we may have one partial fraction with a denominator $(x+1)^2$, and another with a denominator $(x+1)$. For this reason we set it out as follows:

$$\frac{3x^2+4x-2}{(x+1)^2(x-2)}=\frac{A}{(x+1)^2}+\frac{B}{(x+1)}+\frac{C}{(x-2)}.$$

As before, we multiply all along by $(x+1)^2(x-2)$, and so get $3x^2+4x-2=A(x-2)+B(x+1)(x-2)+C(x+1)^2$.

(i.) Put $x=2$.

Then $(12+8-2)=A(2-2)+B(2+1)(2-2)+C(2+1)^2$
$$18=A(0)+B(3)(0)+C(3)^2$$
$$=9C$$
$$\text{or } C=\frac{18}{9}=2.$$

(ii.) Put $x=-1$.

Then $(3-4-2)=A(-1-2)+B(-1+1)(-1-2)+C(-1+1)^2$
$$-3=A(-3)+B(0)(-3)+C(0)^2$$
$$=-3A$$
$$\text{or } A=1.$$

Equating the coefficients of x^2, we get, from $3x^2$ on the left and Bx^2 and Cx^2 on multiplying out the right-hand side, $3=B+C$.

But we already know that $C=2$, and so
$$3=B+2$$
$$\text{or } B=3-2=1$$

Ans. $$\frac{1}{(x+1)^2}+\frac{1}{(x+1)}+\frac{2}{(x-2)}.$$

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Examples for Practice.

Resolve the following into partial fractions:

1. $\frac{3x+4}{x^2+3x+2}$.
2. $\frac{5x+17}{(x+7)(x-2)}$.
3. $\frac{5x+2}{x^2-4}$.
4. $\frac{x}{(x-5)(x+4)}$.
5. $\frac{3x^3+6x-4}{(x^2-7)(x+1)}$.
6. $\frac{7x^2+25x+13}{(x+2)^2(x-1)}$.

SIMULTANEOUS EQUATIONS.

91. Let us suppose that we wish to find the values of two quantities, x and y, and only know that $5x+y=7$. Now we could have an infinite variety of values for $x+y$ which would fulfil the requirements of this equation; for example, any of the following:

$x=10$	2	$\frac{1}{2}$	0	-10
$y=-43$	-3	$4\frac{1}{2}$	7	57

In fact, for any value we like to give to x there will *always* be a corresponding value of y which will make $5x+y$ equal to 7.

Now suppose we know also that $5x+3y=1$. This new equation, dealing with the same x and the same y, obviously limits our choice of values, for x and y have now to fit into *two* different equations instead of into one only.

We have $5x+y=7$

and $5x+3y=1$.

Now, as each left-hand expression equals its corresponding right-hand expression, we can obviously add or subtract the two left-hand expressions, and put their sum (or difference) as equal to the sum (or difference) of the two right-hand expressions.

For example, taking the two equations $5+3=8$

and $4+1=5$,

we can either add them, getting $9+4=13$

or subtract them, getting $1+2=3$.

In our particular case it will be convenient to subtract them.

$$5x+y=7$$
$$5x+3y=1$$

Subtracting $-2y=6$ or $y=-3$.

Thus we have eliminated x in the subtraction, and have been enabled to find the value of y.

Inserting this value $y=-3$ in the first of the two equations, we have

$$5x+y=7$$
$$5x-3=7$$
$$5x=10 \quad \text{or } x=2.$$

Thus the required solution is $x=2$, $y=-3$.

The following examples serve to introduce various "dodges" for the solution of simultaneous equations.

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Example.

Solve the equations $2x+y=15$
$3x-5y=16$

Adding, we get $5x-4y=31$, an equation which does not help us in the slightest. Subtracting, we get $-x+6y=-1$ or $x-6y=1$, and again we are no farther forward. We must obviously adopt some new scheme in order to make either the x terms or the y terms cancel out. The easiest thing to do in the present case is to multiply the first equation all across by 5.

We then get $10x+5y=75$
Now $3x-5y=16$
Adding $13x=91$

$$\text{or } x=\frac{91}{13}=7.$$

Putting $x=7$ in the equation $2x+y=15$
we have $14+y=15$
or $y=15-14=1$.

Ans. $x=7, y=1$.

92. We know that one equation is sufficient (provided it is a suitable one) for finding the value of one unknown, and we have just seen that two equations are necessary for finding two unknowns. Similarly, three quantities can be found only if we have three equations.

Example.

Solve the following equations :

(i) $2x+5y-z=6$
(ii) $5x-8y+2z=8$
(iii) $x+2y-5z=-11$.

We will first of all eliminate z altogether, and to do this we can multiply

equation (i) by 10.....$20x+50y-10z=60$ (iv)
equation (ii) by 5 .....$25x-40y+10z=40$ (v)
and equation (iii) by 2 .....$2x+4y-10z=-22$ (vi)
Add equations (iv) and (v) .....$45x+10y=100$ (vii)
and also equations (v) and (vi) .....$27x-36y=18$ (viii)
Now multiply equation (vii) by 3...$135x+30y=300$
and equation (viii) by 5...$135x-180y=90$
Subtract .....$210y=210$

$$\text{or } y=1.$$

Put this value $y=1$ into equation (vii), and we get

$45x+10=100$
$45x=90$
or $x=2$.

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Put $x=2$ and $y=1$ in equation (i), and we get

$$4+5-z=6$$
$$9-z=6$$
$$z=3$$

Ans. $x=2, y=1, z=3.$

Example.

Find the values of x and y in the equation $y=mx+c$, given that

when $m=1{\cdot}2$, $c=4{\cdot}8$

and when $m=0{\cdot}5$, $c=6{\cdot}2$.

Inserting these values of m and c in the equation, we get

$$y=1{\cdot}2x+4{\cdot}8 \quad \text{(i)}$$
$$\text{and } y=0{\cdot}5x+6{\cdot}2 \quad \text{(ii)}$$

Multiply (i) by $0{\cdot}5 \ldots 0{\cdot}5y=0{\cdot}6x+2{\cdot}4$ (iii)

and (ii) by $1{\cdot}2 \ldots 1{\cdot}2y=0{\cdot}6x+7{\cdot}44$ (iv)

Subtract (iii) from (iv) $\ldots\ldots 0{\cdot}7y=5{\cdot}04$

$$\text{or } y=\frac{5{\cdot}04}{{\cdot}7}=7{\cdot}2.$$

Inserting the value $y=7{\cdot}2$ in equation (i), we get

$$7{\cdot}2=1{\cdot}2x+4{\cdot}8$$
$$1{\cdot}2x=2{\cdot}4$$
$$\text{or } x=2.$$

Ans. $x=2, y=7{\cdot}2.$

Examples for Practice.

Solve the following:

7. $\begin{cases} 3x+5y=25 \\ 2x-3y=4 \end{cases}$

8. $\begin{cases} x+2y=1 \\ 3x-5y=-19 \end{cases}$

9. $\begin{cases} 2a+3=-b \\ 2b+4=-5a \end{cases}$

10. $\begin{cases} 11+2p=8q \\ p+2q=8 \end{cases}$

Find x and y in the following cases:

11. $y=mx+c$
Given that $c=7$ when $m=1$
and $c=8$ when $m=\frac{1}{2}$.

12. $ay-x=b$
Given that $a=7\frac{1}{2}$ when $b=4$
and $a=13$ when $b=15$.

Share Market Report

LONDON, *August 15th*, 1916.

SINCE our last issue there has been rather less business and prices generally a little easier with the exception of Marconi Marine, which have risen 5s. The Ordinary shares are now ex dividend. Marconi Ordinary, £3 3s. 1½d.; Marconi Preference, £2 12s. 6d.; Marconi International Marine, £2 6s. 3d.; American Marconi, 18s. 3d.; Canadian Marconi, 11s.; Spanish and General Wireless Trust, 10s. 9d.

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Radio Farm

Professor Sparkington Gapp takes to Agriculture

By P. W. HARRIS

It was a typical summer's day (temperature 40°, steady rain). Soaked to the skin, I trudged along, vainly endeavouring to shelter myself under the tall trees which skirted the road, and vowing black vengeance upon the friend who had recommended a walking tour in Wiltshire. Great was my joy when around a bend appeared the joyous sign of the "Fly and Thunderbolt," an ancient hostel promising welcome refuge and refreshment.

"First customer to-day!" remarked the landlord dismally as he handed me a foaming tankard.

"Oh! Why this lack of trade?" I asked, sinking into a cosy settle.

"People joining the Army and moving and so forth. There's a cranky old professor running a farm here, who hasn't improved matters either!"

"A professor!" I exclaimed with interest. "Who is he?"

"Name of Sparkington Gapp," replied the host. "Tries to run a farm on what he calls scientific lines. Weird goings-on there are too. My old hen's been laying duck's eggs for a week, and people all round here are moving 'cause they don't know what's up with the place!"

"Sparkington Gapp! Why, he's an old friend of mine!" I cried.

"Oh, you know him, do you," said the landlord suspiciously. "Well, if you walk up the road for a quarter of a mile, until you come to a large white gate marked 'Radio Farm,' that's his place. And tell the old fossil, if you see him, that this was a Christian village till he came. Now it's haunted!"

Leaving the muttering landlord in the sanded bar, I stepped out into the road once more. A gleam of sun was now filtering through the trees, making a walk more pleasant. What a coincidence that I should come across the old professor again!

After walking for a minute or two my attention was arrested by the strange antics of a frog. The little creature had just emerged from a wayside pond and was endeavouring to cross the road. It did not progress by the usual leaps, however, but attempted to walk on the tip of its toes with its head high in the air, and then, with a great effort, it emitted a feeble "Cockadoodle-doo!" and fell over.

Thunderstruck by the strange phenomenon, my mind instantly reverted to the conversation in the "Fly and Thunderbolt." "The place is haunted!" the landlord had said. Truly there was something wrong. What influence was at work, I wondered, to change the poor frog's nature so peculiarly.

After a while I reached the white gate, on which, just as the landlord had said, I saw painted in large letters "Radio Farm. Beware of the Wireless." Without pausing, I pushed it open and entered an avenue which soon terminated in an open field. In the distance I could see a group of buildings and a large umbrella aerial. Stepping out at a good pace, I inhaled the delightful air, when suddenly

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without warning I was thrown to the ground by a violent blow on the chest and legs. Picking myself up, I looked around, but could see nothing; so, considerably mystified, I started my walk again, only to be once more overthrown in precisely the same fashion.

"You can't walk through my wireless fence that way," said a voice from a hedge. "Why, bless me, if it isn't the young man from THE WIRELESS WORLD!"

Turning, I saw my friend the Professor, who was beaming with pleasure and looking the picture of health.

"How do you do, Professor?" I said. "Down at the inn I was told you had a farm here, so I came along to see it. I am sure WIRELESS WORLD readers will be delighted to hear of your latest invention."

"I am sure I shall be only too pleased to show you round," courteously replied the famous scientist. "Since turning my attention to agriculture I have achieved some remarkable successes. But first of all I must let you in." And stepping to a tiny box fastened to a tree, he pressed a button.

"What's that for?" I asked.

"Just to release a section of the wireless fence. Quite a simple idea, you know, the same as a wire fence except that it has no wires, hence its invisibility and your somersault just now. Pray step forward, the way is clear."

We were now in a large field, rich and green and affording excellent pasture for the herd of cows I observed about me. The animals were evidently in good condition, although they had a strange, tired look in their eyes.

"Each cow is allotted so many square feet of grass, and is separated from its neighbour by a low wireless fence," explained Professor Gapp. "You don't see the fences, of course, as having no wire they consequently need no posts to support the wire."

"They are self-supporting, then?"

"Completely. They cost us nothing whatever," was the reply.

From the distant buildings came the sound of a deep bell announcing the passing of three o'clock. Then to my astonishment every cow seemed suddenly galvanised into activity and tore across the field to a long low building, into which it disappeared. Within two minutes the pasture was completely deserted.

"What on earth is the matter?" I exclaimed.

"Milking time," said my guide with pride. 'We milk them every two hours. As soon as the clock strikes an impulse is sent from the main antenna and actuates a coherer tied to the cow's tail. A small relay brings a prickly instrument into circuit and forcibly impels the animals to rush to the shed. There they are milked, by means of a high-frequency oscillatory milkulator (up and down

"THERE'S A CRANKY OLD PROFESSOR RUNNING A FARM HERE."

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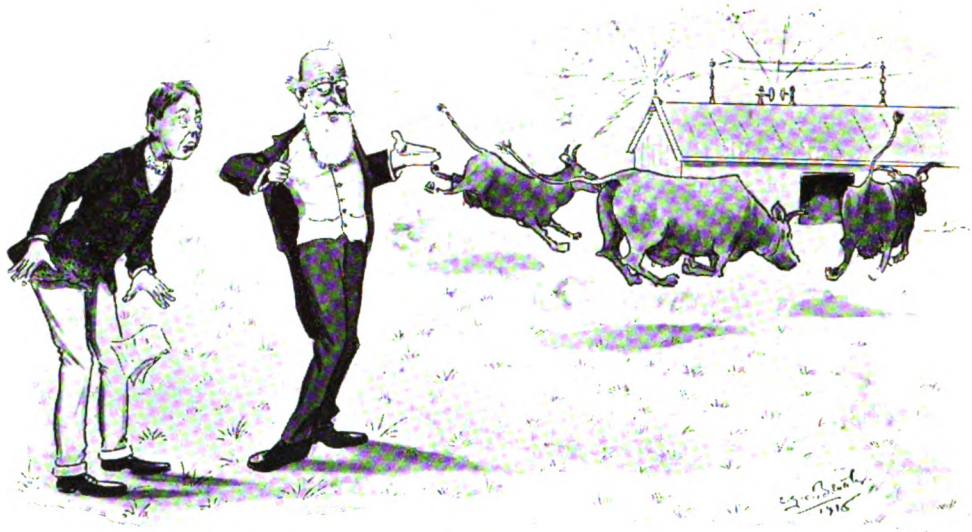

"EVERY COW . . . . TORE ACROSS THE FIELD TO A LONG, LOW BUILDING."

five hundred times per second), and given a pail of phosphorus tonic. At the right moment the jabber comes into action again, and the cows run back to their stations."

And sure enough forty-eight panting Alderneys came tearing out of the shed to take up positions in the field once more.

"Efficiency every time," I said admiringly.

"That's the motto here," smiled the Professor. "In the old-fashioned farms the cows are slowly driven backwards and forwards to the sheds by hand, and at the most are milked twice a day. Here we speed them up and renew their energy with tonic. The phosphorus makes them very intelligent too," continued the scientist.

"Yes?" I said interrogatively.

"Very intelligent indeed. Of course, we do not expect them to attain the intellectual level of a human being, but we already have several who have reached the intelligence of a Cabinet Minister. But come and see the eggery."

We now walked into a large red brick building lined with white tiles and fitted with a number of glass boxes. In each I observed a scared hen, and the whole structure echoed with what seemed like the tapping of a hundred tiny hammers. Mystified, I turned to my guide again. "Please explain," I asked plaintively.

"The noise you hear proceeds from the constant laying of eggs," was the answer. "Let me look at the speedometer. Ah! four hundred. Yes, the speed is improving daily. We have forty hens here, so that means ten eggs per minute from each hen."

"Ten eggs a minute! Good gracious, how on earth do you manage that?"

"Quite simply," explained the Professor. "Look at this main controlling device." Here we paused before a large case in which I saw a fine hen surrounded by inductances and capacities. Two little bulbs were glowing at one end of the case. "This master hen (or perhaps I should say mistress hen) has in its brain the desire

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to lay eggs. This it transmits to the capacity and inductance to which it is attached, and the two bulbs (vacuum valves, you know) amplify the desire one thousand times and radiate it to the other hens about."

"Marvellous!"

"Yes, I must admit it is somewhat above the ordinary. We have had a great deal of trouble, however, in getting the best adjustment. One day the apparatus went off resonance and upset the cows, who started to build nests. We still have a little leakage somewhere."

"That would account for the strange behaviour of a frog I passed in the road. It was trying to crow!"

"Yes, frogs have a similar wave-length. And last week three of my assistants caught chicken-pox through touching the hen without the customary rubber gloves."

"Does not working at high pressure exhaust the hens rapidly?" I next asked.

"Fairly rapidly," replied Professor Gapp. "We work them in relays, the birds off duty being fed on concentrated food, so as to bring up their strength again. Of course they age rapidly, and when they die we sell their flesh for leather."

"Absolutely everything thought of!" I exclaimed.

"Well, we are not perfect," modestly replied my guide, "but we are improving steadily."

The Professor now opened a door and ushered me into the main operating-room, where the hum of machinery made it necessary for us to raise our voices. Seated at various tables were a number of bespectacled young men, each with a chart and a number of switches before him. The centre of the room was occupied by a number of large arc generators, and through the roof projected the insulators of the main aerial.

"These switches," said the Professor, indicating a number of glistening brass handles on a table, "control the condensers of the condensed milk plant. Butter-making is manipulated by the operator at the further table. Cream is first placed in a large capacity connected to a suitable inductance and spark gap. The cream, of course, oscillates in the condenser and inductance, and as a result is rapidly converted into excellent butter. The time-constant of the circuit is adjusted so as to give a pound of butter every five seconds."

"What happens to the butter-milk, then?" I asked.

"There is none," replied my friend. "It all evaporates in the spark gap."

"How you think of every little detail!"

"Yes, I admit we are thorough. Our trouble at present is lack of control of the weather. I have a scheme, however, which I think will solve the problem."

"How do you propose to work it?"

"Well, I cannot reveal details at present, but I may say that by a suitable combination of umbrella aerials and dry cells we hope to get wet and dry weather at will."

What a brain! Such wonderful inventive power! And yet the British neglect of their scientists is proverbial!

"Thank you a thousand times for your kind explanation," I said. "There

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"IN EACH I OBSERVED A SCARED HEN."

is just one point I would like explained before I leave. Whence do you obtain the power to run this plant?"

"Oh, that's easily arranged from the surplus cheese," the Professor answered. "One high-potential Stilton, stepped down through a transformer, will run this plant for a whole day."

"Thank you very much. Now I must be going. Which way must I walk to reach the village?"

"My dear sir, you mustn't walk! I couldn't allow it! Here, Simpkins, take this gentleman down to the village in my aeroplane."

"Your aeroplane! So you have aircraft here?"

"Certainly. Since reading those articles in THE WIRELESS WORLD on Wireless and Aircraft I have experimented a great deal in that direction. We are improving daily, aren't we? 'Experientia Dowsett,' you know! Good-bye!"

"Good-bye! I shouted down as the Farman machine glided into the ethereal blue and the figure of the grand old professor dwindled to a speck on the earth beneath.

And then, far away beneath, I watched the cows scurrying away to the five o'clock milking, whilst from the building below came the monotonous "tap-tap" of the new-laid eggs as they fell into their appointed receptacles.

Engineering in China

As there is a proposed considerable extension to the engineering department of the Pekin University, the Chancellor expressed a desire that models and samples of engineering products of the United Kingdom should be available. The British Engineers' Association, through their energetic secretary, took the matter in hand, pointing out the great possibilities of the Chinese market in connection with engineering generally, and especially the opportunities which are likely to arise for the British manufacturer after the war. Gifts of specific articles of plant and machinery specially required by the students of the University were solicited, and have been freely made. Among those who have offered gifts of plant to the University are Marconi's Wireless Telegraph Co. It is very satisfactory to note that at least as regards the British manufacturers they appear alive as to the future of that market.

A New Edition of "Bangay"

So great has been the popularity of the *Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, that the publishers have now arranged to produce a new revised and enlarged edition at an early date. The price of the new edition will be slightly increased.

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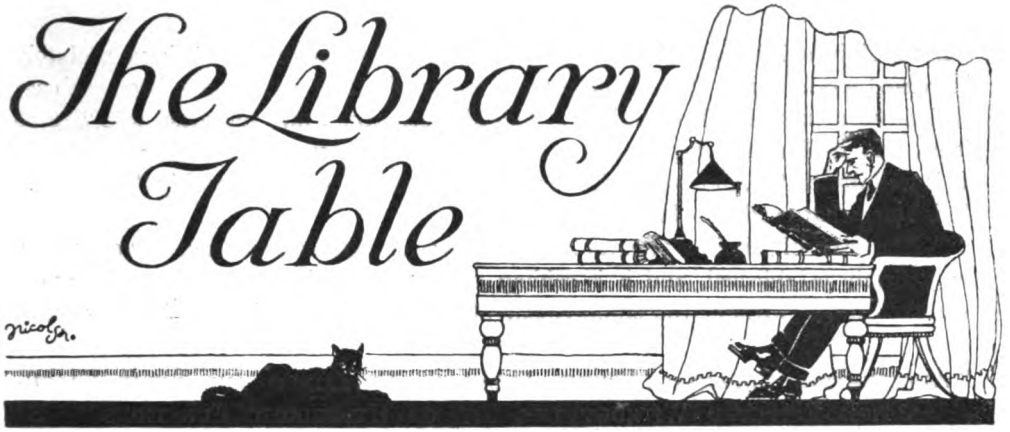
The Library Table



"THE HEART OF EUROPE." By Ralph Adams Cram, Litt.D., LL.D., F.A.I.A., A.N.A., F.R.G.S. London: Macmillan & Co., Ltd. 1916. 10s. 6d. net.

This pleasingly-written work describes in a more or less detailed manner some of the beautiful architecture of the important buildings in what the author refers to as "The Heart of Europe." This cognomen would seem to be particularly applicable. Contemporaneously with the Norman invasion of England there sprang into being in northern France, Flanders, and western Germany the elements of a permanent civilisation. This civilisation commenced to develop through the unspotted efforts of the Church in the twelfth, thirteenth and fourteenth centuries, expanded and enlarged with the careful handling of the guilds and corporate bodies of the fifteenth century, and was finally consummated by the burghers and people of the sixteenth and seventeenth centuries. The divisions of this progress are exemplified in the priceless architectural treasures, which are the heritage, not only of the countries in which they are situated, but of the whole civilised world. Alas! the ogre of war has heavily planted his foot on this once prosperous district. As the result of the barbarous procedure of the modern Huns, many a fine old building now lies in ruins—razed to the ground. And why? With their usual aptitude for excusing their misdeeds, the Germans have proclaimed to the world that military necessity demanded their destruction because they were used by the Allies as observation and signalling posts. The argument that wireless telegraphic masts were erected on the towers, and apparatus set up in the interior of the churches, forms the exact type of excuse that, by custom, we expect from those who so callously and brutally disregard the common principles of humanity. The book is profusely illustrated, and Dr. Cram's fluent style possesses a charm which we are sure will appeal to all our readers.

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"AIRCRAFT IN WAR AND PEACE." By William A. Robson. London: Macmillan & Co., Ltd., 1916. 2s. 6d. net.

To quote the author in his preface to the book, he has "attempted to convey, "in plain non-technical language, a general idea of the conditions under which "aircraft is playing its part in the war, and also to indicate the chief directions

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" in which it is developing." The potentialities and scope of aircraft have probably increased more rapidly during the present embroglio than would have been the case had no war existed. The subject is indeed fascinating, and all those who like to learn and read of the rapid strides being made are advised to procure the book. It is well illustrated, but we think the text might have been considerably " polished." It is somewhat crude in places.

The uses of wireless telegraphy in connection with aeronautics have become very firmly established, and it is seldom now that any important reconnaissances are carried out without the employment of Senatore Marconi's valuable invention.

* * * * * *

" ALTERNATING CURRENTS: THEIR ELEMENTS EXPLAINED AND THEIR CALCULATION EFFECTED WITHOUT THE USE OF HYPERBOLIC FUNCTIONS." By H. R. Kempe. London: Crosby Lockwood & Son. 3s. 6d. net.

The increasing importance of alternating currents in electrical engineering practice and the difficulties encountered by the student in making calculations relating thereto has already called forth a large number of books devoted to the subject. In this book the author endeavours " not only to explain the practical " application of formulæ given in existing text-books, but also to show by what " processes they may be obtained." The author was for some time principal staff engineer and electrician to the British Post Office, and therefore has had a large experience of electrical calculations in practical work. It has been stated by Professor Morecroft that problems in which the current has a continually changing value in consecutive sections of the line, due either to leakage between the two sides of the line or to the capacity of the line, can be accurately solved *only* by the use of hyperbolic trigonometry. In this book Mr. Kempe shows that his statement is hardly a correct one. The volume will no doubt interest many students who wish to go a little more deeply into the subject than is the general rule.

* * * * * *

" THE AEROPLANE." By A. Fage, A.R.C.Sc. London: Charles Griffin & Co., Ltd. 6s. net.

When reviewing the first edition of this book in November last we felt sure that it would make a great appeal to all who are concerned with scientific problems of aviation and the practical construction of aeroplanes. That we were justified in so thinking is proved by the fact that a second and enlarged edition has now been produced. So rapid has been the progress of aviation in the last six months that much new material has had to be added, with the result that we now find over twenty additional pages and some further illustrations. As we stated in the previous review, the book is a scientific work rather than a popular treatise; nevertheless, there are many parts which will interest the lay reader, particularly if he has some acquaintance with engineering. For the practical engineer who intends to take up the study of aviation the book can be highly recommended, and without a doubt the present edition will be exhausted as rapidly as the first.

NOTE.—*Any of the above books will be forwarded by return of post upon receipt of remittance covering cost of book and postage, by the Wireless Press, Ltd., Marconi House, Strand, W.C.*

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Personal Notes

It is our sad duty this month to record the death in action of Pte. John N. W. Green. He first joined the London office of the Marconi Company (Transfer Dept.) in August, 1911, where he remained until October, 1913, in the latter month being transferred to the Belgian Marconi Company. He enlisted, with several members of the London Marconi Company, in the 17th Royal Fusiliers. After some months' training he went to the front in November, 1915, but in an attack on July 27th last he was shot through the lungs and died instantaneously. In a letter which his father received from the Major commanding his company, the following passage occurs :

" He was a very gallant soldier, and died in a charge against the enemy. I am " proud to have had men like your son under my command."

Pte. Green is an only son, and had he lived would have been 21 next month. He was educated at the Mercers' School, Holborn. We are sure the whole-hearted sympathy of our readers will go out to his bereaved father in his time of trouble.

* * * * * *

Members of the Marconi Company's Marine Operating Staff will be interested to hear that Mr. Reginald Cox, who for some time has been engaged upon inspection duties at Avonmouth and Cardiff, entered the married state at the end of June last.

The wedding took place at the pretty little parish church of St. George, Waterlooville, before a large assembly of friends. The bride, Miss Gladys Irene Edwards, is the elder daughter of Lieut.-Commander and Mrs. J. Edwards, of Waterlooville, and was given away by her father. As this is a technical magazine, we will not attempt to describe the dresses worn,

THE LATE PTE. J. N. W. GREEN.

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but we understand that everybody looked charming, and everything went off remarkably well. Mr. Cox's *confrères* in the Marconi Company presented the bridal couple with a handsome barometer as a token of their esteem, and we join with the staff in wishing Mr. and Mrs. Cox every happiness.

* * * * * *

Among the members of the Marconi Company's staff who joined the Army in 1914 was Mr. Frederick Thomasson, who entered the company in 1913. Becoming attached to a wireless section, he had many exciting experiences, and we have just heard that he has been released from hospital, where he spent many months in recovering from severe wounds received in action. He has now been awarded the Croix de Guerre by the French military authorities for conspicuous bravery in action. We are sure our readers will join with us in tendering him our hearty congratulations upon his safe recovery and the decoration awarded him for his gallantry.

* * * * * *

We regret to announce that Wireless Telegraphist James Bertram Dalgleich has lost his life whilst serving his country. He was in his nineteenth year, and resided at Higher Tranmere. His former place of residence was Bootle, and he was well known in the Boys' Brigade there.

SERGEANT RUMFORD.

* * * * * *

Our photograph is of Sergeant Rumford, of the Royal Flying Corps. He is a wireless operator, and whilst in flight over the German lines was shot in the head by enemy airmen, the bullet passing out at the neck. Fortunately he safely reached the British lines, and has since made a complete recovery. The sequel to the incident is that he has been presented at Aldershot with the Russian Order of St. George. He is now at the front again.

* * * * * *

Commander A. E. Silvertop, of H.M.S. *Defence*, which was sunk in the great naval battle off Denmark, was one of the earliest experimenters with wireless telegraphy in the Navy, and was lent to the Somaliland Expedition of 1903 with two sets of Marconi apparatus. By his untimely death the Navy and the nation lose a valuable officer.

* * * * * *

Among the men who went down with H.M.S. *Defence* in the Jutland battle was Wireless Operator Ernest Edward Dawes, the son of a widow living in Catford. He was between 18 and 19 years of age, and had been in the Navy about eighteen months. Our sincere condolences go out to his mother.

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Patent Record

3164. March 2nd. Marconi's Wireless Telegraph Co., Ltd., and H. A. Ewen. Means for suspending and insulating electrical conductors.

3165. March 2nd. Marconi's Wireless Telegraph Co., Ltd., and H. M. Dowsett. Studs or electrodes of electric dischargers.

3166. March 2nd. Improvements in wireless installations for aeroplanes.

3233. March 3rd. Marconi's Wireless Telegraph Co., Ltd., and H. A. Ewen. Improvements in measuring instruments, relays, and the like.

3391. March 7th. British Thomson-Houston Co., Ltd. (General Electric Co.). Vacuum apparatus.

3394. March 7th. H. W. Sullivan. Telegraphic or signalling systems.

3515. March 9th. British Thomson-Houston Co., Ltd. (General Electric Co.). Electron discharge devices.

3533. March 9th. Signal Gesellschaft. Multiple contact microphones. (Convention date, Germany, January 9th, 1915.) (*Accepted.* Patent No. 100156.)

3603. March 10th. British Thomson-Houston Co., Ltd. (General Electric Co.). Means for obtaining high vacua.

3743. March 13th. M. Compare and the Comparri Wireless Control Syndicate. Oscillators or vibrators for wireless telegraphy.

3745. March 13th. Société Française Radio-electrique. Alternators for the production of high-frequency electric oscillations. (Convention date, France, March 13th, 1915.) (*Open to public inspection.* Patent No. 100184.)

3789. March 14th. Marconi's Wireless Telegraph Co., Ltd., and H. A. Ewen. Improvements in measuring instruments, relays, and the like.

3948. March 17th. F. Titterton. Apparatus for transmitting signals.

4096. March 20th. H. Rottenburg. Electric contact keys and buzzers.

4184. March 21st. W. A. Clark, H. G. and W. W. Longford, T. Morris, and the Sphinx Manufacturing Co. Electrical condensers and condenser systems.

4247. March 22nd. British Thomson-Houston Co., Ltd. (General Electric Co.) Electrical transformers.

4295. March 23rd. E. R. Clark. Inductances for wireless telegraphy and method of manufacture thereof.

4320. March 23rd. A. E. McColl. Protecting gear for electric circuits.

4321. March 23rd. A. E. McColl. Means for protecting alternating current generators and transformers.

4399. March 24th. British Thomson-Houston Co., Ltd. (General Electric Co.) Method of controlling mechanism for electric circuits.

4518. March 27. A. Artom. Receiving instrument for wireless signalling.

4558. March 28th. British Thomson-Houston Co., Ltd. (General Electric Co.). Electric discharge apparatus.

4697. March 29th. Electric oscillators.

4733. March 31st. A. E. McColl. Alternating current system.

4816. April 1st. British Thomson-Houston Co., Ltd. (General Electric Co.). Wireless signalling systems.

4959. April 5th. L. de Forest. Electrical means for producing musical notes. (Convention date, United States, April 24th, 1915.)

5111. April 6th. C. P. Ryan. Sound-receiving apparatus.

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Pastimes for Operators

IV.—STUDY

By JOHN WALTON

AN article on study may be legitimately included in this "pastime" series, for surely even the most frivolously inclined do not view amusement as their only means of "passing the time."

Some of us after our days at sea are over, when we find ourselves in strenuous occupation ashore, become exercised with grave doubts as to whether we have wisely used the spare time which was ours, afloat, and regret too late that we shall never have such an opportunity again. Of course, it is useless to "cry "over spilt milk"; but I do feel that I may be doing good service to some of my colleagues in pointing out that, however true the old "saw" may be, which deals with the effect of "all work and no play," even more deplorable are the results of "all play and no work." I have read with much interest and pleasure previous articles in this series, dealing with the subjects of "Banjo Playing" and "Photo-"graphy," but these only appear to touch the fringe of the possibilities available for wireless operators at sea. I should like to suggest for serious consideration the fact that we do not want to remain operators at sea all our lives; we look forward to obtaining other employment and "bettering ourselves" from the point of view of salary. We cannot realise too soon that good jobs ashore at good money have to be worked for, and the man who wants them has got to *know something*. Moreover, there is not only the selfish but the national point of view to be considered. We have not merely to beat the enemy in warfare on land and sea, but also to contend in serious strife with him for the trade of the world. Only individual capacity can help us in this latter contest.

I will confine myself to suggesting subjects which may be studied and mastered from the instruction books without the aid of a tutor. They are subjects, moreover, which a pretty extensive experience of business suggests as being the most useful for general commercial life. Several of them have doubtless been included in the curriculum of your school, but I think my own experience may fairly be taken as typical; and the result of my mental stocktaking is a feeling of surprise at the lack of practical business value of what I learned as a schoolboy.

BOOK-KEEPING.

Undoubtedly the best book on this subject is *The Students' Complete Commercial Book-keeping*, by Arthur Fieldhouse, published at 4s. The principles of the science are here thoroughly taught, while the practice of the art and current business methods receive their due share of attention. Do not forget that you are learning not to keep the books of any particular trade, but the principles of book-keeping and their general application which may be applied to a specific business later on. Besides the text-book all you want is a supply of foolscap ruled with cash columns.

Book-keeping sounds dry; but I have found it an interesting study, and a

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really useful knowledge of the subject can be picked up in a year or so. If you desire to gain certificates (and they are very often a recommendation to a prospective employer) the Society of Arts hold examinations annually and issue Certificates, Grades I., II., and III. A person with, say, a Society of Arts Grade II. certificate is a useful acquisition to any business man's office, and employers have their eyes open for these things.

Shorthand.

There are quite a number of shorthand systems on the market at the present time, each claiming to be the easiest and best, but the almost universal popularity of Pitman's and the failure of its young rivals to obtain any substantial following show that the oldest is still the best.

Pitman's Shorthand Instructor, published at 3s. 6d., a plain ruled book, a little patience, perseverance, and regular practice are all you absolutely require, although Pitman's weekly penny shorthand paper, *The Journal*, forms a useful addition, especially for those who are self-taught. One year's ordinary work should enable you to take down an ordinary letter. I am no "Shorthand Expert," but that amount of study has enabled me to take notes of instructions given and reproduce them in my letters; every chief likes to see his own expressions made use of. As for fear of "sticking in a rut" because you know shorthand, the idea is a simple bogey. If you are born for "a rut," a "rutter" you will be. But do not put it down against your shorthand.

Typewriting.

For all-round business equipment it is undoubtedly desirable to have a knowledge of typewriting and be able to type rapidly. It can hardly be regarded as a separate subject for study—there isn't really anything to study. Buy a second-hand machine for £3 to £5, get a booklet from a typewriting company, and you can spend many a profitable leisure hour in practising the fingering recommended and suiting it to your own idiosyncracies. Do not be satisfied to use one finger, if you can possibly avoid it.

English, Reading, etc.

It is really surprising how rare is the gift of being able to write the King's English well, and yet the ability to do so is one of the things which should be regarded as essential to the aspirant for commercial honours. Apparently it is not entirely a matter of schooling, for I have known men who have been to the Universities who were unable to write a really fluent letter. On the other hand there are those who can outdo Micawber, who never saw the inside of anything higher than a Board School. Nor is it altogether a question of the rules of grammar. I admit that the person who writes well must necessarily have been taught the rudiments of English grammar, but I am still inclined to think there is in it something of what the Londoner said to the professor who was trying to speak Cockney: "Yer can't do it, guv'nor; it's a gift." However, be that as it may, there is no denying the fact that the reading of a really well written letter is one of the pleasures, if one of the rarities, of business life. I suppose there is no royal road to the acquisition of a good style, but a book like W. Stewart Thomson's *Practical Guide to English Composition and Essay Writing* (Simpkin, Marshall) cannot fail to be of value to any who are weak

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in this direction. Diligent reading of the best English authors is also of great assistance.*

While on the subject of English I should like to mention the desirability of being able to make a succinct précis of a batch of correspondence or a number of documents. If we take the marking in Civil Service Examinations as a criterion it would appear that few are able to do this well, for it is a subject in which low marks are the rule. At one examination at which I sat I thought my précis was excellent, but the examiner evidently thought otherwise, and gave me only 160 marks out of 300! Take a newspaper and read a speech reported verbatim in two columns. Try and summarise into twenty or thirty lines, and then compare the result with the sub-editor's work in the Summary Column. You'll soon see the difference!

TECHNICAL.

In addition to the ordinary commercial subjects mentioned there is perhaps an even wider field for study in the direction of technical matters. There are few more interesting subjects than electricity. We are naturally most concerned with its application to telegraphy, and I will confine my remarks to that aspect of the question, although, if you are so inclined, the study of other branches of the science, such as lighting, heating, and power, may advantageously be undertaken.

For students of all scientific and technical subjects a knowledge of mathematics is very desirable, perhaps even essential. I am afraid my mathematics were somewhat neglected at school. At least, when I began to study telegraphy I found my knowledge so rusty that I had to revise pretty extensively. If you are in the same sad plight you will find Castle's *Practical Mathematics for Beginners* (Macmillan, 2s. 6d.) a handy little volume for bringing you "up to scratch." It contains quite enough for the requirements of ordinary students, whose object is mainly to secure facility in the accurate handling of equations, algebraic formula, etc.

MAGNETISM AND ELECTRICITY.

All branches of electrical engineering are dependent upon the application of the phenomena of magnetism and electricity, and the student of electrical subjects is therefore best equipped whose knowledge of the fundamental principles is greatest. With a really thorough groundwork of magnetism and electricity subsequent study of any department of electrical science is comparatively easy; without it no really advanced knowledge either in "wired" or "wireless" is possible.

The subject is an unusually interesting one and in view of its importance deserves careful attention. A very useful and popular book is Hadley's *Magnetism and Electricity for Beginners* (Macmillan, 2s. 6d.), which covers all the ground required to secure the Board of Education's Lower Grade Certificate. For more advanced students the same author's *Magnetism and Electricity for Students* (Macmillan, 6s.) can be thoroughly recommended. The average student would perhaps not require to go beyond the first book, which gives a sufficiently wide treatment of the subject to cover practically all one's needs in telegraphy and telephony. The second book is, however, a valuable contribution to the current literature on the subject, which it treats very exhaustively, and for those studying for the Stage II. examination of

* Try *How to Fail in Literature*, by Andrew Lang. It is most amusing, and instructs on the "what to avoid" principle.—(ED.)

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the Board of Education it cannot be beaten. Of course an invaluable text-book on the subject is the new edition of Sylvanus Thompson's *Electricity and Magnetism* (Macmillan, 4s. 6d.).*

Telegraphy.

To begin with wireless. Although you hold a 1st class P.M.G. you don't really know such a very great deal about the science of wireless telegraphy. From three to six months in the School is not, after all, a great deal to devote to a subject which is of such enthralling interest and for which the future possibilities are so vast. There is still room in this sphere for the inventive genius, and there may be much money and no little fame for those who are able to suggest practical improvements whereby wireless may achieve still further triumphs. And bear this in mind, it isn't always the big engineers who fall on the big ideas. Yes, undoubtedly you might do worse than make a deeper study of wireless. Moreover, your practical association with the work will naturally add to its interest and will also be found very helpful.

Besides wireless, however, there is a very wide field to cover in the study of landline and cable telegraphy. If you are a good wireless operator you will naturally be efficient in an operating capacity ashore, but your usefulness, even as an operator only, will be enhanced by your knowledge of theory, to say nothing of your greatly increased chances of promotion. It is a fallacy to suppose that "line" telegraphy is on its "last legs." Don't believe it. It certainly won't be in our time that all the telegraph wires and cables will be scrapped. So that when you get that comfortable little berth ashore you will naturally be a more valuable servant if you have made a study of modern telegraphic systems as applied to overhead and underground lines and also submarine cables. The book that will cover all your requirements in this direction is Herbert's *Telegraphy* (Whittaker & Co., 7s. 6d.). It is a very comprehensive treatise on telegraphy and starts by assuming that you have no knowledge of the subject whatever, eventually taking you by gradual stages over all the ground required even by a telegraph engineer, which is probably a good deal more than you will want. All forms of automatic working at present in use are thoroughly explained and there are also chapters dealing with line construction and cable laying.

The only recognised certificates in telegraphy are issued by the City and Guilds of London Institute, who hold examinations annually (at the end of April) at all the principal Technical Schools. A first class Grade I. Certificate can usually be gained by a conscientious student who gives an hour a day to the subject for, say, five or six months. The Grade II. (or Honours) Certificate naturally takes more getting, but by the following April a man who is keen may sit at the examination with some degree of confidence. A first class in this grade is, I believe, recognised as the highest certificate that can be gained in the subject.

Telephony.

A somewhat closely allied and equally interesting subject is telephony. It is perhaps not quite so difficult as telegraphy, although the universal use of the telephone makes it of no less importance. It is unlikely, however, that a knowledge of tele-

* The recommendation of electrical text-books is, of course, largely a matter of personal taste and requirements. A perusal of the "Library Table" column in The Wireless World will serve as a useful guide in technical book-buying.—(Ed.)

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phony would be quite so useful or profitable to you as a good knowledge of telegraphy, that is if you intend to remain in the service of a telegraph company. But even so, the subject is one which is worthy of attention, for the telephoning public is on the increase and the development of this service is still far from complete. Poole's *Practical Telephone Handbook* (Whittaker & Co., 6s.) can safely be mentioned as a suitable book for the student.

The City and Guilds of London Institute is also the recognised examining body in this case. Grade I. and Grade II. Certificates are issued and the examinations are held about the same time as those in telegraphy—*i.e.*, towards the end of April in each year.

IN CONCLUSION.

There are no doubt quite a number of other directions in which the studious operator may set himself to work, but unfortunately there is a limit to the amount of space with which a perhaps already over-indulgent editor will favour me. At any rate, it is hoped that enough has been said to assist the operator who is not without a little ambition and who has his eyes on the future, and that he will readily be able to map out for himself a course of study suitable to his tastes. In order that the article might have a general appeal I have purposely confined myself to subjects which, after all, are comparatively simple and which can be successfully taken up by the average person. The subjects are on that account no less useful, in fact they probably represent the things which will be found of most practical value in a business or telegraphic career. Their study cannot fail to repay you and must naturally increase your earning capacity and your sphere of usefulness. It ought to be possible for you to take up something really helpful of this kind and still to have as much spare time on your hands as should properly be given to amusements pure and simple. Finally, do not overlook the fact that by increasing your individual efficiency you are acting patriotically, for you are contributing your share to the maintenance of our commercial supremacy and preparing to take a man's part in the war after the war.

A Correction

In the article on the "Disc Discharger" which appeared in our July issue the word "ignition" in the sixteenth line on page 263 should be "ionization."

On the next page it is stated that the disc is usually provided with two studs per pole of the alternator. Only one stud per pole is used in the majority of cases, giving one spark per half period; but the disc is usually drilled and tapped for two studs per pole so that two sparks per half period may be used in suitable cases.

From New York "Life"

NAVAL COMMANDER: "Did you succeed in intercepting that wireless message to the enemy?" Operator: "Yes, sir. It was addressed to Lieut. Smith, and read, 'It's a boy.'"

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Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, ***Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.***

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

E. P. (Colchester).—We hope to publish next month an article on the training of radio-telegraphists for the naval and military services, which we think will contain the information for which you ask in your first question. (2) Frank Castle's *Practical Mathematics for Technical Students* costs 3s. 6d.; post free, 3s. 10d. from our publishers. We thank you for your appreciative remarks.

M. L. B. (Pocklington).—Land stations in this country are controlled by (1) the Admiralty, (2) the Post Office, (3) the Marconi Company. Operators for the Admiralty stations are selected from the wireless telegraph staff of the Navy; operators for the Post Office stations are recruited from the Inland Telegraph staff and given a special training; operators for the Marconi Company's land stations are all experienced telegraphists who have been given special training by the Marconi Company, and vacancies do not occur very frequently. By far the greatest number of vacancies occur in the Mercantile Marine operating staff, and vacancies on land stations abroad are often filled by men who have had two or three years' experience at sea. If you are new to both telegraphy and wireless work, you will stand very little chance of obtaining employment in a land station either in the United Kingdom or abroad. In reply to your second query, our statement in the August issue that the "age limit of the Marconi Company is 25," means simply that no applicant is accepted who is past this age. Once the man is in the company, however, he will never have to leave because he is too old. If he remains until the age of 60 he will receive a pension. Question 3. See the advertisement pages of THE WIRELESS WORLD for particulars of training schools.

F. J. F. (Nottingham).—A thoroughly sound knowledge of the theory of wireless telegraphy can be obtained by studying *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, price 1s., post free 1s. 2d., and *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, price 3s. 6d., post free 3s. 10d. The first of these books deals mainly with the principles, and the second with the actual apparatus and its manipulation. It is, of course, impossible to learn actual operating and manipulation of the apparatus without attending some training establishment where an installation is available. Most of the training schools advertising in THE WIRELESS WORLD possess such installations for instructional purposes.

PUZZLED (Muswell Hill), writes: "Enclosed "is a sketch of the three circuits of a multiple "tuner from the handbook of Hawkhead. "The primary inductance is shown in two "sections. If this is correct, is there not a "loss of inductance, as it seems to me that only "the inductance of the coil or helix affecting "the intermediate circuit is being worked? "Again it appears that the intermediate "circuit is not adjustable like the primary, "but depends upon its condenser, and I have "always understood that on theoretical "grounds the less C and the more L is better."

Answer.—If our correspondent will study

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the circuits of the multiple tuner carefully he will find that the inductance in the aerial circuit serves two purposes. The aerial tuning inductance is designed to *increase the wave-length* of the aerial, so that longer wave-lengths may be received than would be possible if no aerial tuning inductance were in circuit. The inductance coil affecting the intermediate circuits is used for *coupling* purposes only. On the "stand-bi" adjustment this coupling coil is not in circuit at all. With regard to the intermediate circuit, this is adjustable for a large range of wave-lengths by means of the variable capacity, as it is found better to adjust the circuit this way than by varying the inductance. It is true that in a detector circuit using the valve receiver or certain types of crystal, it is best to have the capacity small and the inductance as large as possible, but this does not apply to an intermediate circuit where the object is merely to pass the oscillation from one circuit to another.

W. H. S. (Broadstairs).—(1) You are quite right regarding the word "knot." This word is much misused, and many writers think that it is a measure of distance, whereas in reality it is a measure of speed. "Twelve knots" means "12 nautical miles per hour." One frequently sees such an expression as this: "The ship was travelling at 12 knots an hour," which is, of course, absurd, meaning that the ship was travelling at a speed of 12 nautical miles per hour per hour! (2) and (3) There is no regulation which prohibits a man from studying the theory and construction of wireless apparatus, but he must do nothing in the constructional line. The back numbers of THE WIRELESS WORLD contain many extremely useful articles dealing with the calculation of wireless apparatus, and our publishers are shortly bringing out a book on such calculations which will be of great value to you. You will see an announcement in our pages in due course. (4) The Postmaster-General's examination consists of tests in sending and receiving, practical manipulation of the apparatus, and oral questioning.

M. E. (Woolwich).—The Marconi gramophone records can be made to give signals in a telephone headpiece by causing the sounds to act on a microphone in series with the telephone headpiece and a cell. The strength of the signals can then be varied by altering the distance between the gramophone and the microphone. With such an arrangement as this, it would, of course, be preferable to have long wires so that the headpiece could be situated in another room. In this way the receiving would not be affected by the sounds from the horn.

A. McC. (Glasgow) asks no less than ten questions, covering four pages of letter paper. This is rather "a tall order," considering the restrictions of our space, but we will endeavour to satisfy him this time. We take this opportunity of requesting correspondents to ask not more than four questions at a time, as we like to be able to answer as many correspondents as possible each month, so that a minimum number may be held over.

Answers.—(1) See an article which we hope to publish next month dealing with the career of wireless telegraphists in the Navy. (2) Capt. B. Newton, to whom we made reference in our December number, was a captain in the Army, and at the time was engaged upon special duties regarding which we can give our correspondent no information. (3) The senior and junior operators on board ship do not hold a rank so high as that of Chief Officer and Chief Engineer. They hold the position of honorary junior officers. (4) You ask if "wireless "telegraph engineering" is as good a branch as the other branches of engineering. This is far too broad a question for a short reply, and much depends on what you mean by "as "good." In engineering, as in many other branches of life, much depends on the man, and there are undoubtedly excellent opportunities for the clever wireless engineer. (5) An honorary officer means an officer who holds that rank by courtesy. (6) On a ship carrying two operators these two men generally do all the wireless work, although occasionally a "listener" is carried as well. (7) On large ships, messages are accepted (and the rates calculated, and charges made) at the inquiry office or purser's office, and from there sent up to the wireless cabin. On other vessels the messages are accepted and dealt with entirely in the wireless cabin. In cases where the messages are accepted at the inquiry office or in the purser's office, an official of the purser's staff either makes the calculation himself or inquires of the operator on the telephone. (8) On a ship carrying two operators it is usual for the senior and junior men to take watches of equal length; but, of course, the senior is responsible for the whole of the wireless work, and will naturally take the most important watch himself. (9) Generally speaking, the operators enjoy the same privileges as the other officers. These privileges vary with the different shipping lines. In some companies the officers are not allowed to participate in deck games in their spare time, but on ships making long voyages this is generally allowed. (10) Operators usually have comfortable quarters immediately adjacent to the operating cabin. On old ships, however, they are sometimes allotted a cabin in the first or second class portion of the ship. The arrangements with regard to meals vary considerably with the different shipping lines. On some ships the operators occupy a table in the first saloon, in others in the second saloon, on other ships, again, they dine in the officers' mess. Now we have answered all your questions, we would point out to you that if you intend to take up wireless operating, you will have to pay much greater attention to your spelling and grammar than you have done in the letter under reply. We find in it no less than

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nine bad spelling errors, the frequent use of "has" for "as," and many other bad mistakes in grammar. Before worrying yourself as to whether a wireless operator in the Navy can rise to the position of an Admiral, don't you think you had better consider whether you can rise to become an operator?

MRS. M. A. H. (Birmingham).—For particulars of wireless training colleges we would refer you to the advertisement pages of THE WIRELESS WORLD. Any of these institutions will be pleased to forward you particulars on application. It is not possible to be apprenticed as a wireless operator. The best course to take is to enter one of the training schools and obtain the Postmaster-General's Certificate, and then to apply to the Marconi Company to see whether there are any vacancies at the moment. As you are close to town we would suggest that you make a personal call at one of the London schools advertised in our pages and discuss the matter with the principal. If there is any other information you require, we shall be only too pleased to give it.

FRANK DE V. (Belgian Army).—Particulars of a number of training schools will be found in THE WIRELESS WORLD, and some of these conduct correspondence courses. We would suggest that you should apply to one of these institutions for particulars.

X. Y. Z. (Portsmouth).—In reply to your query we would refer you to an article which appeared in the August, 1915, issue of THE WIRELESS WORLD, entitled "How to Become a Wireless Operator." With regard to the suggestion contained in your letter, we thank you for it, and would inform you that the matter is already under consideration.

H. B. (Barrow-in-Furness).—(1) A wireless operator employed by the Marconi Company in the merchant service commences at a salary of £1 per week, with, of course, board and lodging free on board ship. Annual increases in salary are given as set forth in the conditions of employment, which can be obtained from the Marconi International Marine Communication Co., Ltd., on application. (2) Yes, the transferring of men from one boat to another is in the hands of the Marconi Company. (3) An operator must be prepared to proceed on any ship to any part of the world as the company may require. The reason of this will be understood when it is considered that some ships remain in port for several months at a time, or lay up for the winter, and, of course, the operator cannot be kept idle all this time.

F. G. S. (British Expeditionary Force), asks: "What difficulties have to be overcome "before wireless signals can be sent from "submerged submarines."

Answer.—As the sea water is a conductor, wireless waves of the type radiated from the aerial of a ship or land station cannot be used. We are sorry that we cannot give you particulars of the latest improvements in signalling between submerged submarines, as, of course, they are veiled in secrecy at the present time.

J. McK. (Alexandria).—To explain your questions satisfactorily would take many pages, and we can only indicate a few points here. Firstly, if the spark gap remains the same, and the condenser is charged more times per second, there is bound to be an increase in *radiated* power. It may not show on the voltmeter and ammeter, but that is no proof. There are other complications to be reckoned with. When the low frequency circuit is properly adjusted to resonance for a particular frequency any alteration in this frequency will reduce the voltage on the condenser, and if the gap has been arcing the reduction in voltage may stop it. No more energy may be absorbed by the converter, but there may be less wastage. In reply to the second query, it is possible to arrange an oscillating circuit in which the condenser only discharges at every third or fourth alternation by carefully adjusting the circuit to resonance. You then obtain a building-up effect in which the amplitude increases at each alternation; some of the French stations work in this way.

Sapper (B.E.F.). — With the experience you have had we think that after the war you should stand a good chance of obtaining employment as a wireless engineer. Of course, your case could not receive consideration whilst you are with His Majesty's Forces, but as soon as you are free you should apply to the Chief Engineer, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, stating your qualifications and asking for conditions of employment. The prospects are good for a good man. Meanwhile obtain Bangay's *Elementary Principles*, advertised in this magazine, and, when you have mastered that, *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett. These two books should prove exactly what you require. Thank you for your good wishes, which we reciprocate.

G. B. (Millom).—Your method of Morse instruction seems to be a good one, although personally we do not favour the method of sending first with long spacing, and later on with short spacing, as this, in our opinion, makes it rather difficult for the pupils to understand the correct proportion of spacing to letters. Slow sending, we think, should be proportionately slow throughout, and this is the method we have adopted in our gramophone records, which you doubtless possess. Our experience is that pupils attain a speed of 10 or 12 words per minute fairly rapidly, and then find it very difficult to increase the speed. As soon as the pupils can receive at

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10 or 12 words per minute, we think it best to give them constant practice with paragraphs sent singly all the time, occasionally introducing code as a variation and to prevent guess-work. By this system an averagely intelligent pupil practising for the time you mention should be able to read 25 words per minute in six months. It is not a bad plan to advise elementary pupils to occupy some of their time in the train, 'bus, or tram by mentally translating advertisement signs, portions of the newspaper, and so on, into morse. This is of the greatest assistance in the early stages.

G. L. (Hunstanton).—We cannot say by whom the present long-distance record is held. Stupendous distances are being spanned almost daily by some of the recently constructed high-power wireless stations, and, as many of these are engaged upon war work, we cannot give particulars as to what they are doing. As an example of what is happening, we were recently informed that practically every night signals from Honolulu are received very strongly in the Falkland Islands, and in a recently issued report Dr. Louis W. Austin, of the United States Naval Radio Service, states that at Darien, in the Panama Canal zone, signals from Nauen, near Berlin (a distance of some 5,800 miles) were received at a strength of 200 times audibility, whilst Arlington, at over 2,000 miles, was received at a strength as great as 2,000 times audibility. This means, of course, that these signals would be capable of being read at from much greater distances if suitable observations could be taken. In the words of an experienced operator, this is sufficiently strong to make the telephones jump about on the table. After the war, when we are able to write of some of the things that are going on now, we hope to give much more startling particulars even than these.

J. N. H. (Yateley).—We cannot say what conditions will exist after the war, but when peace is declared and you are free, we would suggest that you apply to the Chief Engineer, Marconi's Wireless Telegraph Co., Ltd., stating the qualifications you possess and the experience you have had, and inquire whether there is a suitable vacancy for you. Meanwhile, the *Handbook of Technical Instruction*, by J. C. Hawkhead and H. M. Dowsett, price 3s. 6d., post free 3s. 10d., will be of assistance to you.

R. J. A. (Belfast).—All applicants for entry into the Marconi Company's service have to pass a medical examination by the Company's doctor. We cannot say whether the defect you mention will be sufficiently serious to debar you from the service, and in order to make certain you would have to be examined by the Company's doctor.

A. P. T. (Towcester).—We hope to publish next month an article which will give you the information you require regarding wireless in the Army.

NEW READER (Stoke Newington).—(1) Applicants for employment on the marine operating staff of the Marconi Company must have sufficiently good eyesight to be able to carry out their duties efficiently. The fact that the applicant has to wear glasses does not debar him, provided his sight with the glasses is considered sufficiently good. (2) THE WIRELESS WORLD examinations are postponed until after the war. (3) There is no age limit for the Postmaster-General's examination. The examination comprises tests in sending and receiving, knowledge of theory, ability to trace faults in the installation on which the candidate is being examined, and a practical knowledge of the instruments. In order to pass the examination it is absolutely essential that the candidate should have practical experience of the apparatus, and this is most readily obtained by studying at one of the wireless training schools where such installations are provided.

PERIKON (Worcester).—(1) The Marconi Official Gramophone Records can be obtained from the Wireless Press, Ltd., and we would refer you to our advertising pages, where you will find full particulars. (2) In reply to your radio-goniometer question, 90° is due east, 180° due south, 270° due west and 0 or 360° due north; 94° is, therefore, practically east. (3) You should apply to the Marconi Company as soon as you are free giving particulars of yourself and asking whether they have any vacancy to offer you. Everything depends upon the conditions at the time.

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British Association Meeting

The Goldschmidt Station at Eilvese

Naval Telegraphists: Their Life & Training

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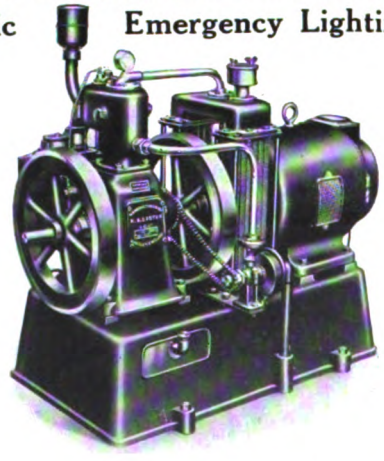

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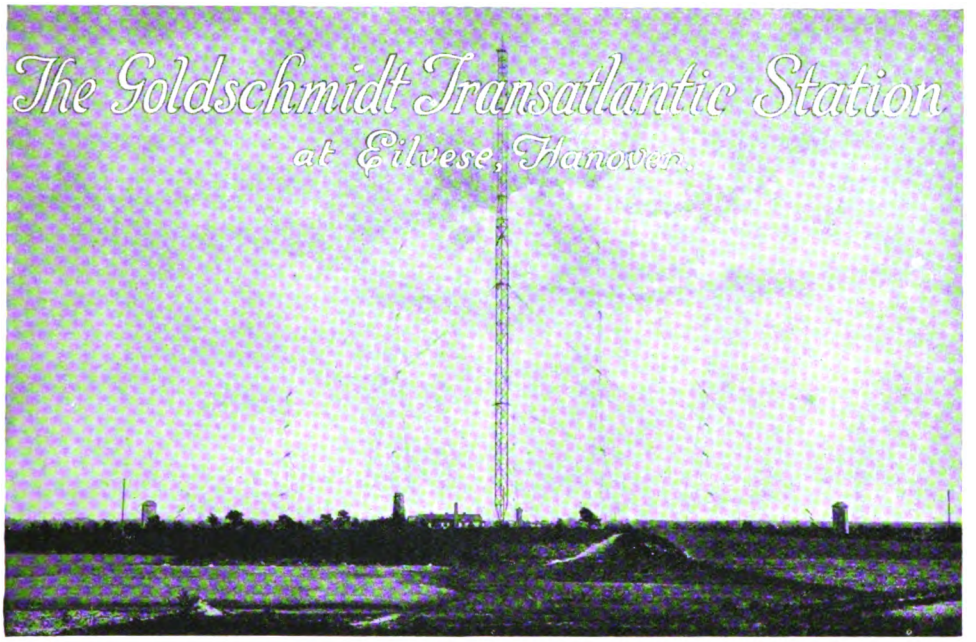

A GENERAL VIEW OF THE HIGH POWER WIRELESS TELEGRAPH STATION AT EILVESE.

AMONG the wireless stations to which Germany has had recourse since the British severed the German cables in 1914, that of Eilvese, in the province of Hanover, holds a prominent place. This giant station, which is situated near Neustadt and not far from the capital town of Hanover, was originally erected for the purpose of demonstrating the inventions of Dr. Rudolph Goldschmidt, including the now famous Goldschmidt High Frequency Alternator and the Goldschmidt Tone-wheel. At the outbreak of war, however, it was taken over by the German Government, and for the past two years has been used to transmit across the Atlantic those telegrams which the Kaiser and his staff consider it necessary that the American people should receive.

From the engineering as well as from the " wireless " point of view the station has many interesting features. Situated in the midst of country which is flat, somewhat marshy and eminently suitable for the erection of a wireless telegraph installation, the Eilvese Station is a landmark by reason of its giant mast. This rears itself to the dizzy height of over 750 feet, and supports an elaborate antenna of the umbrella type. The appearance of the station as it strikes the German peasant working on the fertile Hanoverian plains will be gathered from the heading of our article, in which the height of the tower seems accentuated by the extreme flatness of the surrounding country. On closer examination the mast reveals itself as a triangular lattice structure of steel, the base being brought almost to a point and resting on a large insulating pedestal. The foot of the mast is supported on a number

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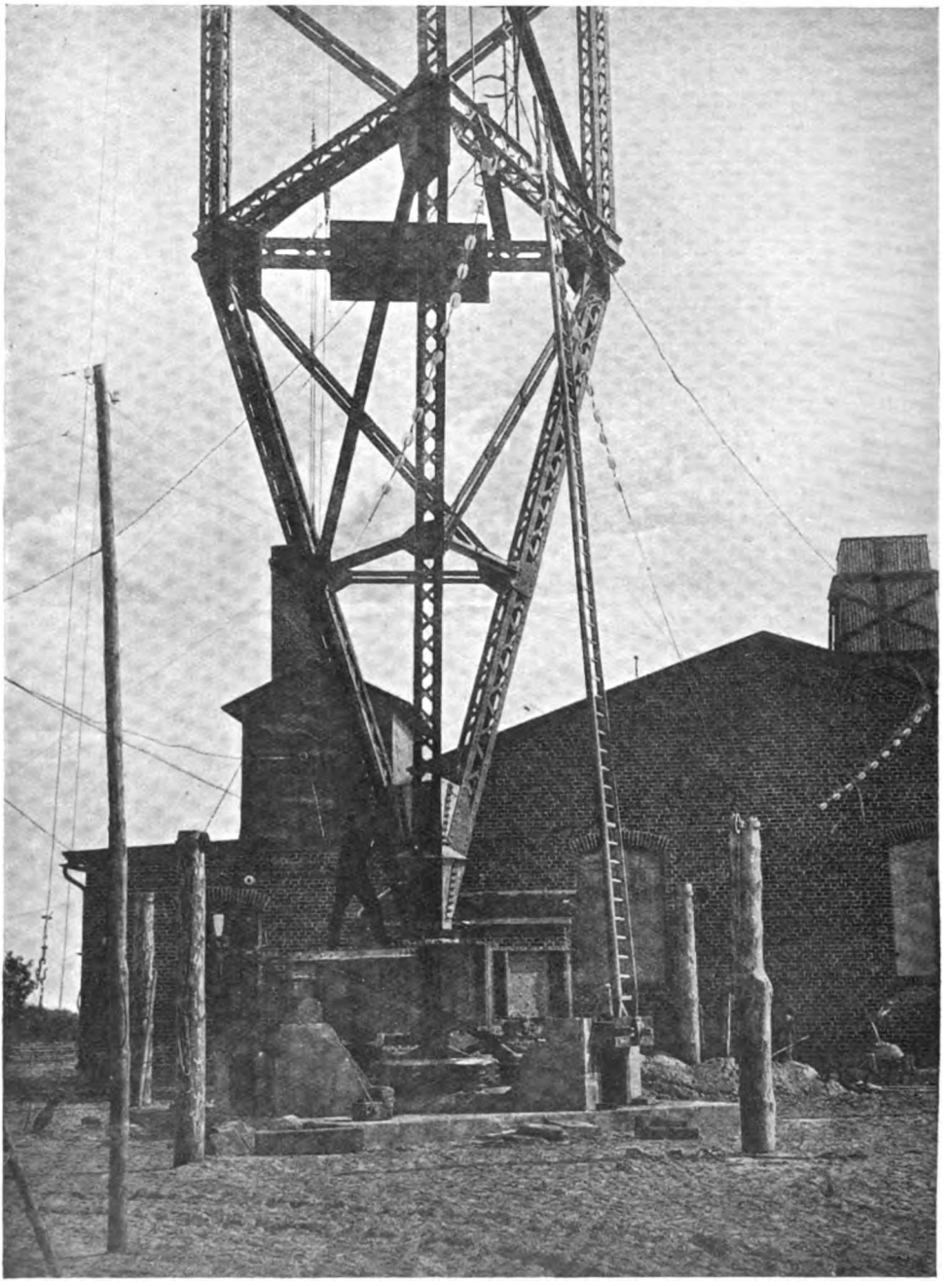

THE BASE OF THE TRIANGULAR STEEL MAINMAST. AT THE TIME THIS PHOTOGRAPH WAS TAKEN THE CONSTRUCTIONAL WORK WAS INCOMPLETE.

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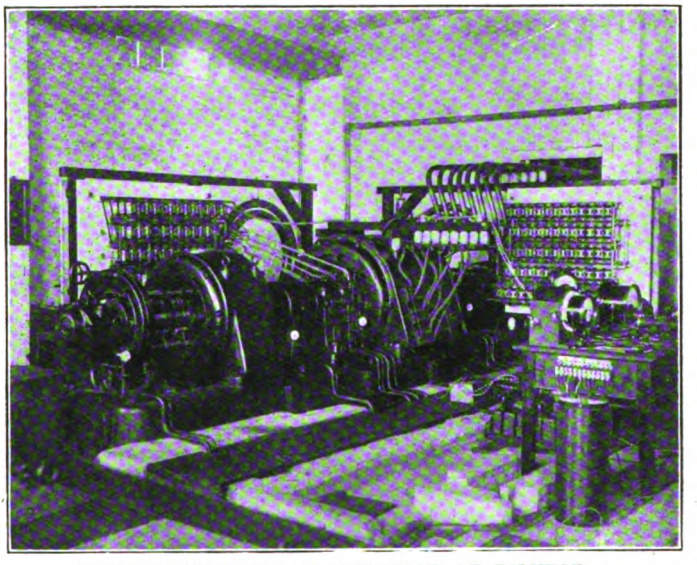
of short glass pillars, which, being subject to compression only, form excellent insulators. An insulating joint is also inserted in the middle of the tower. The aerial wires are stretched out to a circle of poles each 40 feet high, the ends of the guy-ropes which support the tower being fastened to reinforced steel beams sunk in heavy foundations. The photograph on page 510 excellently illustrates the staying of the guy-ropes, and the size of the anchoring structure will be realised by comparing it with the figure of the man standing beneath it. Inside the station building we find a 400 h.p. "Wolf" engine, boiler and engine being constructed together. Such an arrangement is economical and occupies a minimum of space. This engine provides the power for running the station.

The most interesting part of the whole installation is undoubtedly the Goldschmidt High Frequency Alternator. The machine here fitted has a normal output of 100 kw. high frequency current, although if necessary its yield can be forced up to nearly double this figure. In the limitations of our space we can only indicate the underlying principles of this machine, which is really one of the most ingenious pieces of wireless apparatus ever invented. Briefly, then, the Goldschmidt machine is a combined generator and frequency transformer. The alternating current which is produced in the rotor creates in the field circuit another alternating current, which in turn serves to produce a higher frequency alternating current in the rotor, and so on backwards and forwards by what is known as the "reflection" principle. Each frequency oscillates in its own tuned circuit possessing carefully arranged capacities and inductances. For reasons into which we cannot enter here, it is desirable that there be not more than four or five reflections in the machine, consequently it is necessary to have an unusually high fundamental frequency. For example, to obtain a wave-length of 6,000 metres—a wave-length frequently used in transatlantic work—a frequency of 50,000 cycles per second is necessary. If not more than five reflections are used, the initial frequency must be 10,000 cycles, and for this a very high rotor speed and a large number of poles are required. Using the best materials and the highest engineering skill, the maximum speed which can be safely maintained on the periphery of the rotor is about 600 feet per



THE GOLDSCHMIDT ALTERNATOR AT EILVESE.

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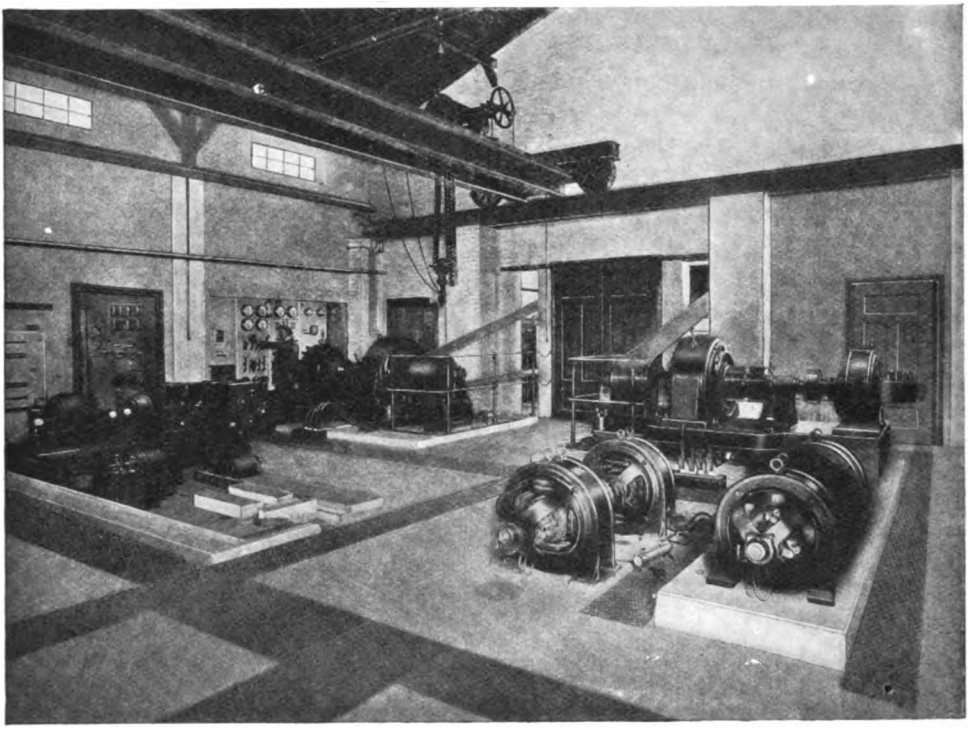

THE DYNAMO ROOM AT EILVESE STATION.

second for a speed of 3,000 revolutions per minute, and for this the diameter of the rotating portion of the machine will scarcely exceed four feet.

In the machine used at Eilvese the width of each pole is one centimetre, and there is only one conductor in each slot. When such high frequencies are used the iron used in the magnetic field must necessarily be of the very best quality and well laminated. To keep the eddy current as small as possible steel of a thickness of ·05 millimetre is used, insulated by paper about ·03 of a millimetre thick. In this way the body of the rotor and of the stator is more than one-third made up of paper! The clearance between the rotor and the stator is a trifle more than $\frac{1}{32}$nd of an inch, and when we consider that the rotor has to revolve at a peripheral speed of over 600 feet per second, and in addition weighs no less than five tons, we see how carefully the machine has to be made. In the illustration which we give on the previous page the driving motor of the 100 kw. machine is seen on the left of the base plate and the alternator itself on the right. On the racks fastened to the wall will be seen the condensers which are shunted across the various inductances to form the oscillating circuits. On the table are situated the ammeters, voltmeters and other measuring instruments.

With this machine there is, of course, no need for a spark gap, for the alternator can be connected directly to the aerial. In order that the frequency of the antenna may be adjusted to that of the machine a large aerial tuning inductance coil is used, consisting of a large spiral of copper tubing.

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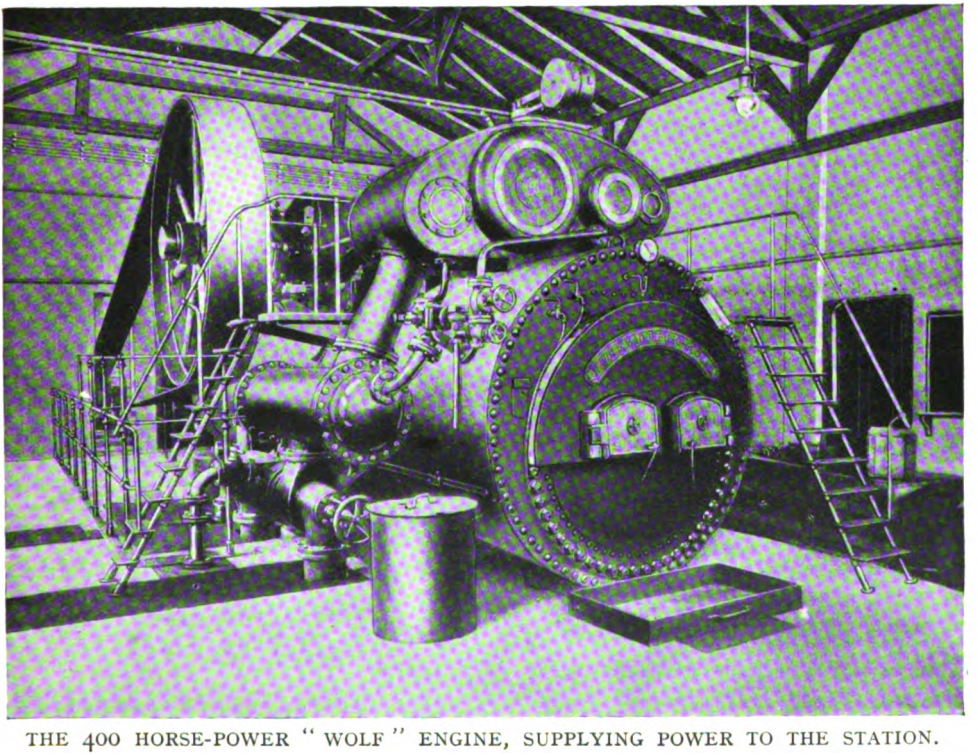
The problem of breaking up the large current into dots and dashes is, of course, an important one. Dr. Goldschmidt has overcome the difficulty by placing the transmitting key in the exciter circuit of the alternator, where of course a comparatively small current has to be broken. This method has proved very successful in practice.

The Eilvese radio station works to a similar station at Tuckerton, New Jersey, nearly 4,000 miles away. As both of these stations radiate continuous waves, special receiving apparatus has to be installed. This takes the form of what is known as the " tone-wheel," an ingenious instrument which is really a commutator. The principle of operation is as follows : A simple toothed wheel, acting as a make and break commutator, has such a number of teeth or poles that, at a reasonable speed, its interruptions are synchronous with the incoming frequency. For example, 800 teeth on the wheel would produce a frequency of interruption of 50,000 cycles per second. If this commutator is run at such a speed that the frequency of interruption is exactly the same as the wave frequency it is desired to receive, no sound will be heard in the telephones connected thereto. If, however, the speed of interruption is slightly lower or higher, the received current will not be perfectly rectified and a " beat " effect will be produced. The frequency of this " beat " current will be equal to the difference between the frequency of the incoming waves and the frequency of interruption. Thus, if the wave frequency is 50,000 per second and the interruption frequency 49,500, the " beat " frequency will be 500 per second,



THE 400 HORSE-POWER " WOLF " ENGINE, SUPPLYING POWER TO THE STATION.

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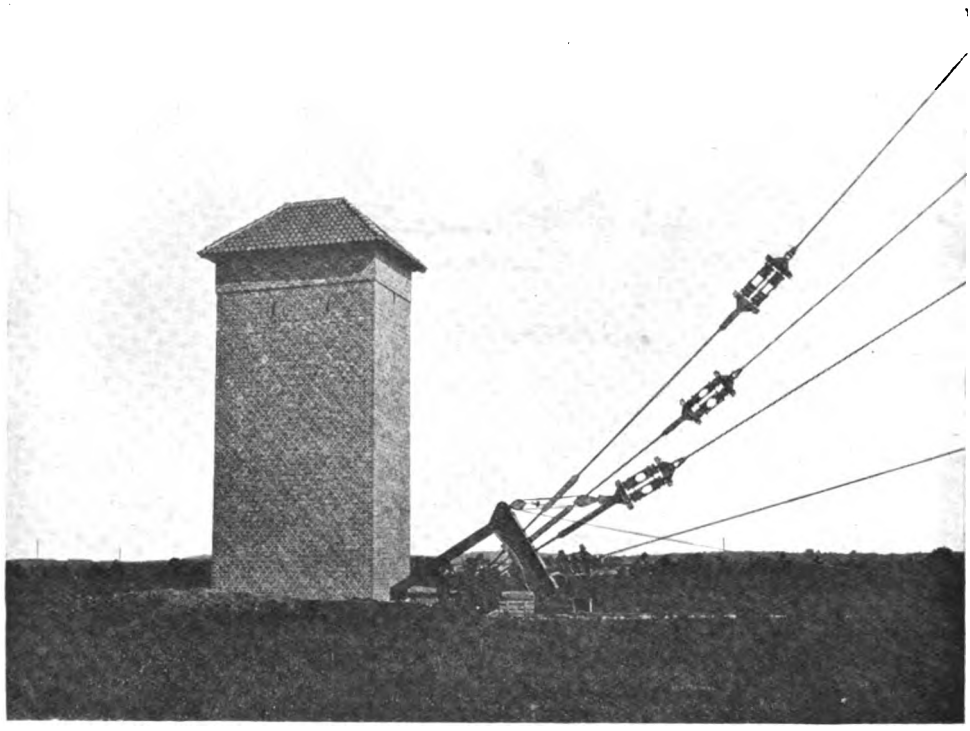

ONE OF THE LARGE STRUCTURES TO WHICH THE GUY ROPES SUPPORTING THE MAST ARE ANCHORED.

giving a pleasing musical note. A very slight difference in the wave-length from any interfering continuous wave station will produce quite a different sound in the telephone, and enable the receiving operator to define the signal readily.

Of course, the tone-wheel is not the only means by which continuous waves can be received. The principle of "beat" reception can be applied to several forms of the vacuum valve receiver, and, in fact, this method is largely used at the present time. The "tikker," another continuous wave detector, depends for its action upon the rapid interruption of a circuit, the note received depending upon the speed of interruption. Its main defect is that the note produced is harsh and non-musical, while its sensitivity is not high.

As regular readers of THE WIRELESS WORLD will know, the Marconi Company some time ago and prior to the war acquired rights in Professor Goldschmidt's patents. For further information regarding the high frequency alternator and the tone-wheel we would refer our readers to the "Wireless Telegraphists' Pocket Book," by Dr. J. A. Fleming, published by the Wireless Press, Ltd., and to an excellent article on the Goldschmidt system which appeared in the "Proceedings" of the Institute of Radio Engineers for March, 1914. To this latter source the writer would like to express his indebtedness.

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Australian Naval Wireless Service

OUR contemporary, the *Melbourne Age*, recently reported that it had been decided by the Commonwealth Government to transfer all the work of the wireless branch of the Post Office to the control of the naval authorities. A large deputation representing the staff of the Government radio service waited upon the Minister for the Navy to protest against the reorganisation scheme, which places the personnel under naval discipline and conditions.

The deputation was introduced by Mr. Chanter, M.P. The deputation was held in private, but subsequently a statement was issued by the Minister. Members of the deputation pointed out that the wireless staff objected to signing on, under the new scheme, as chief petty officers, as by so doing they would lose the social status they enjoyed as officers of the professional division of the public service, and claimed that they should be given the rank of warrant officer. They also objected to the minimum salary offered. Engineer operators had responsible duties, censoring messages and dealing with secret and confidential matters, and the minimum salary should be for men now in the service £204. Under the Naval Board's proposal many men would receive less than their present total salary. Men entering the service in future should receive a minimum salary of £180. They also asked that increments should be paid annually instead of biennially as suggested, and urged that the allowance for uniform, £7, was not nearly sufficient. They asked also for better hospital conditions, as it was not desirable that officers should have to occupy the same quarters as the coloured population. They objected to working overtime without pay; to the fixing of the retiring age at 57, as against 65 in the public service, and to other conditions pertaining under naval control.

The Minister, in reply, explained the various advantages of the department's proposal, whereby officers who were now in practically temporary positions in the public service were being given an offer of permanent employment in the Royal Australian naval radio service. The salary of no officer was being reduced, and to compensate for the loss of overtime and Sunday pay each officer was being placed on a higher subdivision of salary. In his opinion a generous offer was being made to employés, and they could rely on getting fair treatment in the administration of the new conditions.

It may be pointed out, in connection with the above, that wireless employés are to be ranked in the naval radio service as follows: Lieutenants, £350 to £425; commissioned warrant officers, £255 to £325; warrant officers, £222 to £254; chief petty officers, £156 to £216. They will wear the naval uniform of their rank, and work under general naval discipline and conditions.

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PERSONALITIES IN THE WIRELESS WORLD

Photo by] [*Paul Thompson*

MR. ROY A. WEAGANT

Chief Engineer, Marconi Wireless Telegraph Company of America

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THE year 1881 witnessed the birth of Mr. Roy A. Weagant, who was destined to become the Chief Engineer of the Marconi Wireless Telegraph Co. of America. This event took place on British soil—to be precise, at Morrisburg, Ontario, Canada. Mr. Weagant was educated at Stanstead College, Stanstead, Quebec, and at McGill University, Montreal. His aspirations led him to the study of electricity, and he graduated from an electrical engineering course in 1905. He then studied physics under Sir Ernest Brotherford, and it was through witnessing some of his tutor's experiments in Hertzian Waves that his interest in Wireless Telegraphy was first aroused. The time was now ripe for seeking engineering experience. First he joined the Montreal Light, Heat and Power Company, then the Westinghouse Electric Manufacturing Company of Pittsburg, Pennsylvania, and afterwards the De Laval Steam Turbine Co. In regard to wireless work, Mr. Weagant first took this up in 1908 with Professor R. A. Fessenden. He entered the service of the American Marconi Company in 1912, and he is now their chief consultant on all matters appertaining to the engineering side of their wireless business. Mr. Weagant is a Fellow of the American Institute of Radio-Engineers, and holds an honoured position as one of the Directors of that institution. His activities have also been requisitioned in connection with the Standardization Committee of the same Society.

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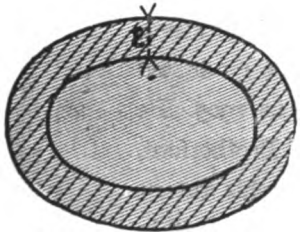
A New Abac for the Calculation of High Frequency Resistance

By C. BAILLIE

THE well known Maxwell and Hertz equations (as well as Kirchhoff theory) applied to a conductor having a conductivity c, permeability μ (electromagnetic units) and conveying a damped high frequency current, give the following results :—

The current is confined to a thin outer layer or skin.

The conductor opposes to the alternating current a certain ohmic resistance which can be defined as the ratio of the heat energy dissipated in the conductor to the mean square value of the current.



Cross section of conductor

To a steady current, the intensity of which is equal to the R.M.S. value of the alternating current, the same resistance would be opposed by a conductor having a cross section s such as the shaded section. As soon as we know this section s we can calculate the required high frequency resistance R by

$$R=\frac{l}{cs}$$

l being the length of the conductor.

It has been shown (Boucherot) that this section has always a very small thickness ϵ given by :—

$$\epsilon=\frac{1}{\sqrt{2\pi\mu c\omega}}$$

ω being the pulsation of the current and equal to 2π multiplied by the frequency n.

Hence we can get s by multiplying ϵ by the perimeter p of the cross section (p in centimetres). Then the required resistance is :

$$R=\frac{l}{cs}=\frac{l\sqrt{2\pi\mu c\omega}}{cp}$$

Introducing the resistivity $\rho=\frac{1}{c}$ and the frequency $n=\frac{\omega}{2\pi}$, $R=\frac{2\pi\sqrt{\mu n\rho}}{10^9.\ p}$ ohms per unit-length (centimetre) of conductor.

We can express R in terms of the wave length λ meters of the oscillation assuming this last to be travelling at a speed of 3.10^{10} centimetres per second.

Then $R=\frac{2\pi\sqrt{6\pi}}{10^5.\ p}\cdot\sqrt{\frac{\mu\rho}{\lambda}}$ ohms per unit length of conductor.

These two formulæ are solved by the "abac" reproduced herewith.

We have assumed the conductor to be of a non-magnetic metal (copper, aluminium, etc.) ; then $\mu=1$.

Let AA^1 and BB^1 be two parallel straight lines (Fig. 1) and let C be the middle of AB. Draw CC^1 parallel to AA^1. Take a point P on AA^1 such as $AP=log\ n$, and a point Q on BB^1 such as $BQ=log\ \rho$. Then draw the straight line PQ and let S be the meeting of PQ and CC^1.

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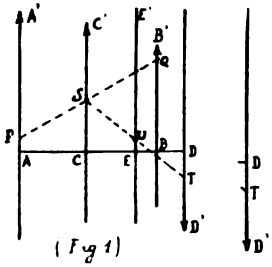


(Fig 1)

Since $AC=CB$ we have $CS=\frac{AP+BQ}{2}=\frac{1}{2}(\log n+\log \rho)$ or $CS=\log \sqrt{n\rho}$.

Let DD^1 and EE^1 be straight lines both parallel to AA^1 and EE^1 being equidistant from CC^1 and DD^1. Now take a point T on DD^1 such as $DT=\log p$, the direction DD^1 being opposite to CC^1. Draw ST and let U be the meeting of ST and EE^1. Since $CE=ED$ we have $EU=CS\sim DT$ that is to say, $EU=\log \sqrt{n\rho}\sim\log p$ or $EU=\log \frac{\sqrt{n\rho}}{p}$.

Since $R=\frac{2\pi}{10^9}\frac{\sqrt{n\rho}}{p}$ we have $\log R=\log \frac{2\pi}{10^9}+EU$, or $\log R=9{,}79818+EU$.

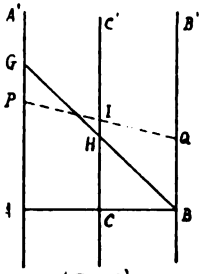
The second formula can be solved in the same way :—

$$\lambda \text{ meters}=\frac{3.10^8}{n} \text{ hence } \log \lambda=8{,}47712-\log n.$$

Take a point G (Fig. 2) on AA^1 such as $AG=8{,}47712$. Then $GP=GA-AP=8{,}47712-\log n=\log \lambda$.

Therefore we can graduate the scale AA^1 in wave lengths as well as in frequencies. This has been done on the accompanying abac which supplies the required H.F. resistance by mean of two alignments.

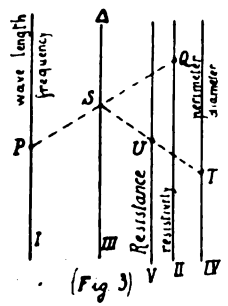
The resistivities scale has been graduated on one side assuming these resistivities to be expressed in electromagnetic units ; on the other side strokes have been drawn in front of usual metals resistivities. The following values have been admitted :—



(Fig 2)

SPECIFIC RESISTANCE IN ELECTROMAGNETIC UNITS AT 20° CENTIG. (68° FAHR.)

Annealed standard copper (industrial copper)	1,724*
Industrial aluminium, hard	2,732 †
Idem. , annealed	2,708 †
Silver	1,683
Gold	2,462
Mercury	94,070
Pure platinum	12,290
Manganese copper (70 per cent. copper) ...	100,600
Phosphor bronze } (telegraphic wires) ...	1,600
Siliceous bronze } (telegraphic wires) ...	1,650
Aluminium bronze (10 per cent. aluminium)...	12,310



(Fig 3)

For greater convenience, on the right side of the perimeters scale have been recorded the corresponding diameters of cylindrical wires. The numbers of the perimeters scale may be divided (or multiplied) by 10, 100, 1,000,

* International Electrotechnical Commission, Berlin, 1913.
† According to Pittsburg Reduction Co. measurements.

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etc., provided the numbers of H.F. resistances scale be multiplied (or divided) by 10, 100, 1,000, etc.

Suppose it is required to obtain the H.F. resistance per centimetre length of a copper conductor having a rectangular cross-section 3 cm. long and 0,4 cm. broad, and conveying a current of frequency 300,000. The perimeter is $p = 2 \times 3 + 2 \times 0{,}4 = 6{,}8$. Join by a straight line (the edge of a rule) point 300,000 of scale I. to point 1,724 of scale II. (Fig. 3). This line cross scale III. at *S*. Join by a straight line *S* to point 6,8 of scale IV. The H.F. resistance will be read at the point *U* where this line cross scale V.

Pittsburg Patient Uses Wireless Equipment

By FRANK C. PERKINS

THE accompanying illustration shows the wireless equipment of Paul F. Shuey as utilised by him while a patient in the Tuberculosis League Hospital, Pittsburg, Pa. Even though he was confined to a couch on a sleeping porch for several months, the time passed more quickly and pleasantly by the aid of his wireless telegraph apparatus. While a University graduate he was engaged at work on a fellowship at the Mellon Institute for Scientific Research. When he went to the hospital he could not endure idleness, and while in bed continued his electrical studies and rigged up a wireless outfit.

It will be seen that the wireless apparatus was placed on the wall at his bedside, and the aerial was spread from a mast on the roof of the hospital building, the outfit being installed primarily to get the correct time from the United States Observatory at Washington. The enjoyment of picking up messages from the air, however, was great, and he improved his outfit and was able to listen to messages *en route* to the station at Sayville, Long Island, which receives the German war bulletins. The baseball scores were received regularly during the season from the Arlington station, and he has communicated with many amateur wireless operators within a radius of 100 miles of his station.

Photo by] [*Frank C. Perkins.*

MR. SHUEY AND HIS INSTALLATION.

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Digest of Wireless Literature

Handling the Transmitting Key.

Mr. Carl Dreher contributes to *The Wireless Age* an article containing many valuable hints to wireless operators in the handling of the transmitting key. It is rather difficult to impress on young operators who are desirous of cultivating a clear, even style of sending, the necessity of following certain definite rules. One reason for this tendency to learn telegraphy in a slipshod manner lies in the fact that many operators habitually violate all the rules of sending and yet manage to be understood.

All operators learning to manipulate a key appear to have certain tendencies in common. Prominent among these are, firstly, a desire to " tap " the key—that is, to exert a force on it only during the down stroke, letting the spring send it up again ; and secondly, the habit of sending almost entirely with the fingers, hardly any use being made of the muscles of the wrist and forearm.

The first of these faults is not very serious, because every operator discards it automatically as soon as he begins to get up speed, and discovers that the only way to do so is to keep hold of the key knob lightly all the time. The habit of " finger " sending is less easily detected and is much more harmful in its results. Finger sending is almost always " choppy " and laboured. This is bad enough, but as a matter of fact the " knuckle-sender " is lucky if he can transmit at all. He is reasonably certain, sooner or later, to fall a victim to the affliction known as telegraphists' cramp—a paralysis of the fingers and muscles which compels the sufferer to turn to some other field of endeavour.

The correct method of sending is with the forearm, the elbow being used as a fulcrum with a small amount of wrist motion and very little finger work for delicate touches. This throws the heavy part of the work on the muscles of the forearm, which are obviously much better adapted for continued strains than the lighter muscles in the wrist and fingers.

Quoting from T. Jarrard Smith's pamphlet on the " Philosophy and Practice of Morse Telegraphy," Mr. Carl Dreher says that the nature of the grip upon the key should be similar to that in seizing a pen. It should be light, gentle, but even and sure. It must be firm enough to secure unquestioning obedience of the lever, but must not be rigid. The worst thing that an operator can do is to attempt premature high-speed transmission. Quite a number of men have acquired permanently jerky, convulsive, ragged sending by attempting high-speed work before they can satisfactorily handle lower speeds. Nothing disconcerts a receiving operator more than constant variations and jumps in the speed of transmission. Good spacing is largely a matter of experience and ear training.

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Direct Current Transmitters.

In the *Proceedings of the Institute of Radio Engineers* for August Mr. Bowden Washington contributes an interesting paper on " Some Direct Current Sets." The

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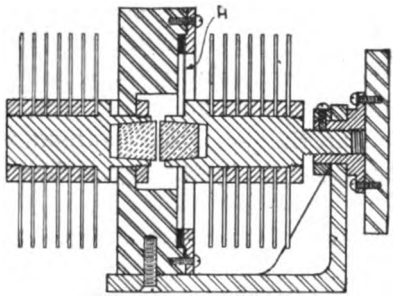

FIG. 1.

apparatus described utilises a special form of discharger invented by Dr. E Leon Chaffee, of Harvard University, in which the discharge takes place between a copper anode and an aluminium cathode in an atmosphere of moist hydrogen. The accompanying figure shows the gap in section. It has been found extremely difficult to build a gap which is adjustable for gap length and is also hydrogen tight. All manner of threads and stuffing boxes have been tried without success. The total adjustment required is very small, probably never being over $\frac{1}{16}$th inch, so a thin phosphor bronze diaphragm has been adopted as shown in the section at A. This pushes in and out like the bottom of an oil-can, and has been found very satisfactory. The periphery of this diaphragm is clamped against a soft rubber packing by a brass ring, held to the bakelite gap chamber by eight machine screws. The base is a small composition casting. Cooling fins and the adjusting handle are shown. The connections are as in Fig. 2. When the direct current feed circuit is closed the primary condenser, C_1, is charged until a potential is reached which is sufficient to break down the gap. The condenser discharges through the gap in a single loop, or half cycle. The gap then goes out and leaves the secondary circuit free to oscillate at its own period. Meanwhile the condenser, C_1, is being re-charged from the generator. When it has reached a potential almost sufficient to break down the gap again the E.M.F. induced in the primary circuit by the oscillating antenna is sufficient to " trigger off " the gap in the proper phase relation to the antenna ; which process continues indefinitely. There is no resonance between the primary and radiating circuits, and to obtain the best energy transfer it has been found advisable to tune the primary to a wave length 1·5 to 2 times that of the secondary.

The capacity and inductance marked C_t and L_t in Fig, 2 constitute what is known as a " tone circuit," the capacity and inductance being of such a value as to give an audible frequency. The effect of this circuit is to give a " beat " effect and to cause the transmitter to emit signals which can be read at the receiving station as a musical note.

These gaps, of course, require a good deal higher potential in starting than the average drop across the gap, which latter is all the generator need supply. To give the additional voltage required for starting, a " starting circuit " has been introduced consisting of an inductance of the order of 0·1 Henry (L_s) a capacity of 0·06 m.f. (C_s) and a resistance approximately equal to the average resistance of the gaps

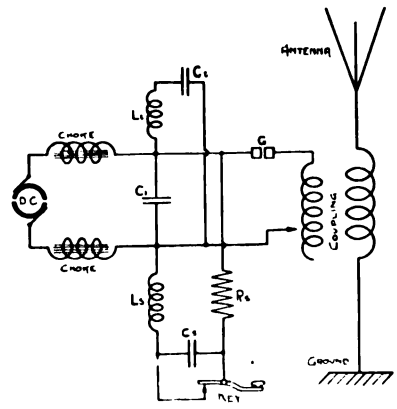

FIG. 2.

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(R_s). The key is shunted across this condenser and opens the circuit when depressed. The current from the generator flows through the key, inductance, and resistance. When the key is opened it breaks the current quickly, owing to the condenser, and thus the energy stored up in the choke coils and the "starting inductance" produces a high voltage sufficient to start the gap, which continues to operate in a normal manner. The resistance in this circuit is, by the way, sufficient to keep it from causing a tone effect.

Recently it has been found possible to substitute alcohol vapour for the hydrogen with great success.

* * * * * *

WIRELESS AND THE WORLD'S TIME.

In view of the success attending the "Summer Time Act," says the *World's Work*, why not pursue the revision of the whole system of measuring time to its logical conclusion and bring it more closely into conformity with modern high-pressure methods and life? In other words, why not introduce World Time? Under the Summer Time Act we say that it is one o'clock in the afternoon, but the man at the transit tells you it is only 12 o'clock. Yet both are correct.

Nevertheless no one can maintain that a time-measuring system is commercially correct which says it is noon in London, but 7 a.m. in New York, 11.34 a.m. in Dublin and 2.1 p.m. in Petrograd. The issue is additionally complicated at the moment because some countries have adopted the daylight saving scheme and have advanced their clocks by one hour, while other nations have steadfastly declined to favour the innovation and still refuse to acknowledge aught but local or mean solar time.

Our present system of measuring time was introduced centuries before a thought was given to mile-a-minute expresses, 25-knot steamers, telegraphy, cables, telephony, wireless, and other similar rapid methods of locomotion and communication to travellers. During early railway days in these islands the clocks always appeared to be "at sixes and sevens." The timepieces in Manchester appeared to lag some eight minutes behind those of the Metropolis, while the clocks of Yarmouth would persist in being about eight minutes in advance of London. As the railway and telegraph increased in popularity hopeless confusion arose. The difficulty was finally overcome by declaring Great Britain as a single zone throughout which common time was to prevail, noon at Land's End being coincident with noon in London, although there is a difference of some twenty-four minutes in time between the two points. In America, of course, things became far worse, and as the country developed some drastic action became imperative. The upshot was the division of the country into six zones, each approximately corresponding to fifteen degrees of longitude west of Greenwich, and accepting Greenwich time as the standard. Wireless has rendered our present system hopelessly antiquated. The need for revision was brought home very forcibly during the recent wireless telephonic communication in America. The conversation delivered into the transmitter at New York was received at the station at Honolulu. Now the local time at the latter point is five hours thirty-six minutes behind New York. Upon receiving confirmation of the receipt of the message at such and such an hour Honolulu time, it was necessary to resolve the information into New York time. Such calculations are essential in all experi-

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ments concerning long-distance high-speed communication, and they have conduced to error, but if the clocks gave a common reading the necessity for calculations would not arise.

In 1884 a determined effort was made to revise the clock and to establish universal time, but the congress which assembled at Washington to deliberate upon this proposal came to naught. But wireless was not known in those days. Seeing that the greater part of the world is at present in the melting pot and that revolutions are promised in several vital questions pertaining to our future industrial and social life, has not the opportunity arrived to revise our time-measuring system ?

Marconi's Wireless Telegraph Company's Educational Classes for Messengers

AT the reopening of the above classes on Monday, September 4th, at the Wild Street L.C.C. School, prizes, generously provided by the company as an inducement to greater effort, were distributed to those boys who obtained at least 150 marks out of a possible 180 at the examinations held during the Session 1915–16.

The parents of all the boys received an invitation to be present on the occasion, and several attended.

The traffic manager distributed the prizes, and expressed great pleasure in having such a task to perform. In the course of his remarks to the lads and parents who were present, he urged the former to apply themselves zealously to their studies during the present Session, at the end of which he would be more than pleased to see two or three tables laden with prizes for distribution, and he regretted that the number of awards earned this time was small. However, he was glad to note that the prizes chosen by the boys were books and instruments of a purely educational nature, which should prove of great value to them in the course of their further studies. The value of the classes as fitting the boys for better positions in the Marconi Company was emphasised, and in this connection it may be mentioned that the company is one of the few where the messenger service is not a *cul de sac*, for every boy has a chance of a permanent position on the staff in the direction his abilities point.

The names of the messengers who merited prizes are as follows :

C. F. Rainbow		1st Prize (177 marks)
G. Wilson and Q. S. F. Mills	each	2nd Prizes (169 marks)
E. Monkhouse		3rd Prize (156 marks)
G. R. Sinfield		4th Prize (151 marks)

In addition, Mr. Matthews, the L.C.C. Responsible Master, very kindly contributed two other prizes to boys who did good work during the Session—viz. :

Messenger F. J. Lloyd Messenger F. W. Pitfield

The occasion was also marked by the presence of Mr. Godwin, one of the L.C.C. Inspectors, and Mr. Matthews, the Responsible Master, both of whom spoke very encouragingly to the boys.

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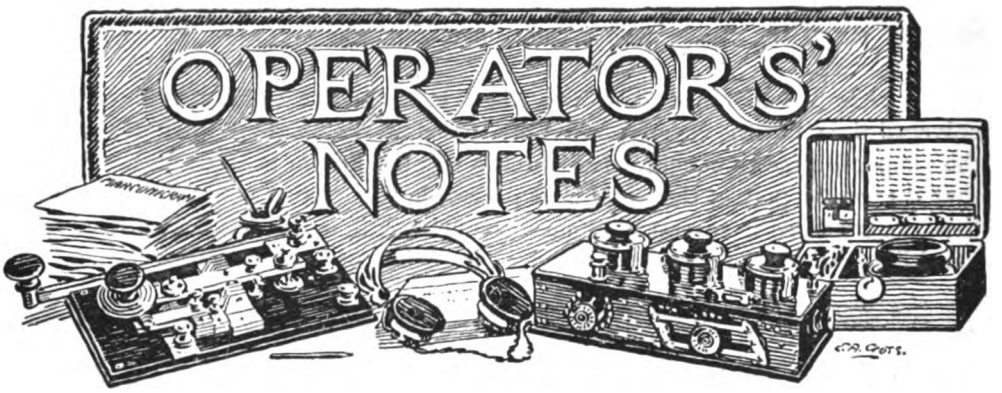

The Preservation of Aerial Insulators.

Every operator, upon taking over a Marconi installation on board ship, will find in his store of spare parts and useful sundries a can of the black liquid known as bitumastic solution. This substance, which has for its base the mineral product bitumen, contains, among other substances, a preparation of indiarubber in a solvent which gives the solution its spirituous odour. Properly used, it is one of the most valuable preservatives for certain insulators which are subjected to rain, salt spray and the general effects of exposure. Improperly used, it may cause a great deal of harm, as many operators know to their cost. Generally speaking, it may be said that the only use to which the solution may safely be put is that of coating the flexible strops which insulate the aerial from the mast.

These strops, with their hemp core, are covered with a flexible rubber compound, which without some protection is liable to deteriorate after prolonged exposure. An untreated strop insulator will in time develop on its surface a number of minute cracks, which considerably lessen its insulating power and enable the moisture to penetrate into the core with disastrous results. At as frequent intervals as are conveniently possible the aerial should be lowered and the strops thoroughly cleaned so as to remove all dirt, smoke, dried salt, and the like, which are liable to accumulate thereon. About once in three months the strops should be cleaned with methylated spirit, if this is available, and a thin, even coating of bitumastic solution applied with the brush. So soon as this coating has dried, and not before, a second painting should be given and the strop hung up to dry. Many operators are able to keep a spare set of strop insulators ready cleaned and coated to replace the set in use at any moment. This is by far the best plan, for it is better to clean and coat the insulators at leisure than to keep the aerial down while the set of strops is being cleaned, painted, and dried. It is, of course, unnecessary to point out that the aerial should never be lowered when there is any possibility of the wireless service being required.

As soon as the painting is finished the brush should be carefully cleaned, and as far as possible all trace of the solution removed, for if the brush is allowed to dry with the solution upon it, it will become as hard as stone and practically useless for

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any further work. A suitable solution for cleaning should be easily obtainable from the engineers.

With ebonite rod insulators, the Bradfield Tube, the Turnbull insulators, and in all cases where the insulating material is ebonite, bitumastic solution should never be applied, as a thorough cleaning of the ebonite surface is all that is required to maintain perfect insulation. Frequent rubbing with a dry cloth will preserve the Bradfield tube in excellent condition, but if dirt accumulates thereon a paraffined cloth will remove it. The same remark applies to the other ebonite insulators to which we have referred.

The cans of bitumastic solution must be carefully and closely corked to prevent evaporation of the solvent and the consequent spoiling of the contents. Just as much of the solution as it is thought will be required should be poured out each time into a small container, such as an empty cigarette tin, and applied as needed. It is practically useless to leave a quantity of the substance in an open tin for use on some other occasion, as it quickly evaporates and becomes hard.

A Norwegian Reader

WITHIN the last few years the study and practice of Radio-Telegraphy has made an appeal to a large number of amateurs, mostly in foreign countries. The United Kingdom possesses her share of wireless enthusiasts, but the United States probably comes first with many thousands of these scientifically-minded young men. And the cult is worth fostering. The practical utility of wireless has already been more than demonstrated, and a knowledge of its intricacies would form a very important asset to the individual. We have been in communication for some time with a young Norwegian, living at Fjosanger, near Bergen, who, at our request, relates how he first became interested in Senatore Marconi's wonderful invention. He says :—

" I first became interested in wireless telegraphy in March 1913, when my father started receiving THE WIRELESS WORLD. At that time I did not know anything about telegraphy, or in fact electricity, nor did I understand twenty words about English, so you see my knowledge was not very extensive. My father continued to receive THE WIRELESS WORLD every month, and as soon as he had finished with it, I took it, although I was not able to read it. Subsequently I learned some more English, and have ever since been interested in wireless. Whom have I to thank for my interest in wireless ? No doubt THE WIRELESS WORLD, or still more yourself, Mr. Editor, as if you had not sent THE WIRELESS WORLD to my father I should not have known anything about wireless now. Therefore, I am very thankful, and will be as long as I live. Perhaps in the future I shall be able to thank you much more, and in better English than I can at present ; but it is from the bottom of my heart I wish you and THE WIRELESS WORLD every success and a very long life. Last year I possessed a small transmitting and receiving station, but I have been compelled to close it down, as the Norwegian law forbids all private persons to have wireless apparatus."

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Mrs. Adrian Porter's Biography of Sir John Henniker Heaton, Bart.*

REVIEWED BY H. J. B. WARD, B.A.

IT is not easy for very close relations to write a satisfactory biography of an eminent man recently passed away. The nearness of any object is almost bound to prevent the proper realisation of true perspective. Mrs. Porter's life of her father, Sir John Henniker Heaton, suffers a little from this inherent disadvantage; so that, every now and again, we find that we "cannot see the wood for the trees." Having said this, we have finished with any remark in the way of adverse criticism we have got to make, and may proceed to dwell with pleasure upon a few of the many attractive features of a delightful book.

It is not very long ago since, in THE WIRELESS WORLD, we paid a well-deserved tribute of praise to Australia for the service to the Motherland of that most virile colony. We might almost add the life work of H. H. to the credit side of the Australian ledger; for although Sir John spent the first sixteen years of his life (1848–1864) in Kent, the County of England (according to Mr. Jingle) renowned from time immemorial "for cherries and women," he may almost be counted as an "Antipodean." It was in Australia that he built up the iron constitution which stood him in such good stead in later years; it was in Australia that, turning from bush life and gold-seeking to journalism, he made his mark and his money; it was in Australia that he first learned by personal experience and observation of the pitiful shortcomings of the British Post Office. Over and above all, it was in Australia that he met "Rose Lorraine," the wife who through all the years of his strenuous life continued to be his true comrade and "Best Beloved."

Sir John's voyages to and from the land of the kangaroo were very numerous, and he maintained to the last his close connection with the Australasian Colonies. Mr. Joseph Chamberlain, both when he was at the Colonial Office, and after his health-enforced retirement, made him the medium of communication between himself and the Australians. This fact is alluded to in a touching letter from the great British statesman, reprinted in Mrs. Porter's biography.

Amongst the many personal friendships which formed so striking a feature of Sir John's career, a close and prominent part was played by Senatore Marconi, who was in the habit of placing at the disposal of the great Postal Reformer, whenever he went ocean-travelling, the Wireless Service carried by the liners which conveyed him. *Apropos* of this tribute of courtesy, we cannot do better than quote Mrs. Porter's words, culled from her description of an Australian voyage:—"Every morning the news of the world was flashed across the great ocean, and at breakfast the daily bulletin was laid on Henniker Heaton's plate." His daughter and biographer continues by describing her father's reception on April 17th, 1912, when in the midst of the Indian Ocean, of the wireless message conveying intelligence of

* *The Life and Letters of Sir John Henniker Heaton, Bart.* By Mrs. Adrian Porter. London, 1916. John Lane. 10s. 6d. net.

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the terrible disaster of the *Titanic*, an occasion which brought home to the world at large the incalculable value of Marconi's invention and led directly to the "Safety of Life at Sea" Convention.

It will easily be understood that a man with a life purpose like Sir John's would necessarily be drawn by the closest bonds of sympathy to the great inventor, who more than any other will bring within the realm of "Practical Politics" Henniker Heaton's idea of *telegrams to all parts of the British Empire at the cost of 1d. per word, with a minimum total charge of one shilling*. This projected reform will be found enshrined in Sir John's sketch of an ideal Post Office on pages 233 to 239 of the biography.

As a matter of fact, apart from their links of sheer intellectuality and common plans for the world's advancement, the two men were united by the closest personal ties and "saw each other almost daily for many years." Sir John stood as godfather to Senatore Marconi's pretty little daughter Degna, and yielded to no one in admiration of his fairylike godchild. On the occasion of the coronation of King Edward VII (August 9th, 1902), Henniker Heaton gave a breakfast party in the House of Commons at which host and guests appeared in full levee costumes. After the breakfast the Postal Reformer and world-famous Scientist were photographed together on the Terrace of the House by Sir Benjamin Stone. This photograph forms one of the most interesting illustrations appended to the volume, and —by the courtesy of Mrs. Porter—we are able here to reproduce the picture.

Photo from [*Life and Letters of Sir John Henniker Heaton.*

SENATORE MARCONI AND SIR JOHN ON CORONATION DAY, 1902.

As far as Wireless Telegraphy is concerned, H. H.'s faith never faltered from the time of his first coming into contact with the great Italian. He rejoiced in what had already been achieved, and looked forward with high hopes to the accomplishments of the future. "Whenever a new invention or development of a former one had reached a stage suitable for investigation, Henniker Heaton was always one of the first to be consulted, and his sympathetic attention never failed."

In view of this unquenchable interest in Wire-

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less inventions, we may recall the fact that Sir John undertook a long journey, in company with Senatore Marconi, to see an invention of Sir Hiram Maxim's for preventing collisions at sea. And he would have been one of the first to hail with delight the recent announcement made to the Press by Mr. Godfrey Isaacs that the Senatore had recently brought to practical perfection an invention of his own, which is believed to go as far as is possible for human ingenuity in the direction of ensuring against such calamities in days to come.

Amongst his many Parliamentary friends Sir John numbered the Chairman of the Royal Mail Steam Packet Co., Sir Owen Philipps (whose name, by the way, is misspelt in the biography), and under his auspices visited South America with his family in 1910. Mrs. Porter speaks with pardonable rapture of the glories of Rio Harbour, and of the intense interest which every member of the little family party took in the wonderful Ibero-American Continent.

We all remember the famous poem of Leigh Hunt concerning Rabbi Ben Ahmed, who was favoured by the Recording Angel with a peep at the Roll on which he was busily setting down the various claims of different human beings for a place in Paradise. The Rabbi asked, "Write me as one who loves his fellow men." The Angel wrote; and when next the great Jewish teacher saw the Roll, "Abu Ben Ahmed's name led all the rest." Sir John Henniker Heaton belonged to the same noble section of humanity as did Ben Ahmed. He loved his fellow men, and nothing gave him greater satisfaction than to be of service to them, either individually or collectively. Naturally the social side of life "loomed large" in his career. Mrs. Porter's account of her father abounds in incidents illustrating this delightful trait, and the volume before us contains a number of capital stories. A favourite playful hit of Sir John's at enthusiastic philatelists consisted of a reference to the stamp collector whose pursuit of his hobby had resulted in a sad lack of worldly gear. According to Sir John, this stamp collector was reduced to publishing the advertisement "Wanted—to meet a lady possessing a 2d. blue Mauritius stamp, with a view to matrimony." Space will not permit of our making any extensive quotations, and we must refer lovers of anecdote to the volume itself.

The results achieved by a really great reformer like the subject of Mrs. Porter's biography form their best memorial. So long as British postal activities continue, the names of Hill and Heaton must endure. But more than that: "Their works do follow them." When at the close of the war we find 1d. postage established as the best possible commercial link between England and all her Allies, whilst possibly substantial progress be achieved with radio-telegraphic aid towards the "1d. telegram" ideal, we shall recall with profound gratitude and admiration the pioneer work of him whose efficient and persistent sapping enabled the victory to be won.

Promotion for Senatore Marconi

READERS will be interested to hear that Senatore Marconi, who has been acting for some time as a Lieutenant in the Italian Army, has now been promoted to the rank of temporary Captain in the Navy of our gallant Ally. Always fond of the sea, Captain Marconi will doubtless find his new duty very congenial.

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Administrative Notes

Bolivia.

RADIOTELEGRAPHIC communication has been established by way of trial between Belem (Pará), Brazil, and Riberalta (Bolivia), this latter being a region which up to now was not connected up with the Bolivian telegraph system.

Messages which the public may be desirous of sending by this means to Riberalta will be accepted at sender's risk, marked *via* " Libres-Radio Belem," and will be charged for at 84 centavos gold per word.

RADIOTELEGRAPHIC TARIFF.

The executive body, by a decree dated November 17th, fixed the following radiotelegraph rates for home and international radiotelegrams of simple category :

Inland Radiotelegrams.	Per Word. Paper $
Coastal station tax	0.15
Ship's station tax	0.10
Total	0.25

International Radiograms.	Per Word. Gold $
Coastal station tax	0.12
Ship's station tax	0.08
Total	0.20

The minimum tax for each message shall be $2.50 paper for inland messages and $2 gold for international messages of 10 words. By inland messages are to be understood those exchanged between fixed stations in the country and ships registered in the country, and by international messages must be understood those exchanged between fixed stations in the country and ships registered abroad.

As the said decree does not give the radiotelegraph tariff charges to be applied to special radiograms, the Direction-General, as per resolution of April 29th last, taking into account the dispositions relating to the international regulations as regards radiotelegraphy, and the way in which the telegraph rates have been fixed for various categories of telegrams, has ordered that inland telegrams, and also international telegrams, shall be subject to the following radiotelegraph rates.

INTERIOR SERVICE.

(*a*) Simple radiogram in Spanish language : $2.50 paper for the first ten words and 25 centavos paper for each succeeding word.

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(*b*) Radiogram in a foreign language: double the amount mentioned in paragraph *a*.

(*c*) Radiogram in secret language: four times the amount mentioned in paragraph *a*.

(*d*) Collated radiogram: same rate as under paragraph *c*.

(*e*) Multiple radiogram: plus the radiotelegraph rate to be charged according to category *a* fixed rate of 50 centavos paper for each address less one.

(*f*) Radiogram "urgent" or with "acknowledgment of receipt," the radiotelegraph rate established for a simple message, and

(*g*) "Reply paid" radiogram: besides the radiotelegraph rate corresponding to the message one way, the rate applicable to the reply telegram according to its category.

INTERNATIONAL SERVICE.

(*a*) Simple radiogram written in any of the authorised languages or in secret language: $2 gold for the first ten words and 20 centavos gold for every succeeding word.

(*b*) "Collated" radiogram: a surplus tax equal to one-fourth part of the total of coastal and ship's tax to be added to the tax to be charged, according to the length of the message.

(*c*) "Multiple" radiogram: over and above the message, a fixed fee of 10 centavos gold for each address less one.

(*d*) "Urgent" telegrams and "acknowledgment of receipt" as per the rate given in paragraph *a*, and

(*e*) "Reply paid" messages, over and above the rate charged for transmission one way, the rate will be charged for the reply according to its category.

* * * * * *

Chili.

In a circular which has just been issued, the Chilian State Telegraph Office advises that the tariff for wireless telegrams in any language, or in cypher, for vessels of any nationality, sent from one of the coastal stations is $5.50 gold for the first ten words, and 55 cents gold for every additional word. For radio telegrams sent from one wireless station to another $4 currency will be charged for the first ten words and 40 cents for each additional word. If messages have to pass over the lines of other companies an additional charge will be made. Wireless telegrams for Port Stanley, Falkland Islands, will be charged $6.50 gold, and 65 cents gold for every additional word. Press telegrams will be accepted at half tariff rates.

* * * * * *

Ecuador.

The Republic of Ecuador has recently enacted strict laws pertaining to radio communication within its jurisdiction. In substance they are as follows: All wireless stations situated in the country or in territorial waters are subject to the inspection and vigilance of the Government. No subject of any of the belligerent countries shall be employed in any of the stations. No message in cipher or code from a belligerent nation or vessel shall be transmitted or received with the exception of those referring to the Government service. No belligerent warship may make use of the wireless apparatus while in Ecuadorian waters. The transmission of a

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wireless message, even in ordinary language, indicating the course of either a belligerent or neutral warship, is prohibited.

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Society Islands.

A radio-telegraph tariff has been issued of 12 cents a word (10 cents wireless charge and 2 cents telegraphic charge from Papeete to the station at Mahima). An additional charge of 24 cents a word is made for relaying via the wireless stations at Apia, Samoa, and Awanui, New Zealand. Tariff rates are also provided between the colony and vessels at sea. All messages must pass through New Zealand to Tahiti, and are subject to war restrictions.

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United States.

The Superintendent of Naval Radio Service has announced that, effective on and after July 1st, it will be obligatory on the part of senders of radiograms to be handled by the Naval Radio Service to indicate in address of the message the class of vessel it is desired to reach by this service, such as S.S. (steamship or steamer), or U.S.S. (United States ship), as the case may be. This order becomes necessary owing to the confusion in proper handling of such traffic because of a large number of names of ships being the same as cities, towns, etc. The extra word will be charged for and counted in the check.

The United States Bureau of Navigation has announced that the following regulation, which is made pursuant to the Act of August 13, 1912, should follow Paragraph 152, Page 66, of the Radio Laws and Regulations of the United States :

" Paragraph 152a, page 66.

" Holders of commercial extra first-grade radio operators' licenses may be " issued renewal of such licenses without examination, provided the service records " on the backs of the licenses properly certify to twelve months' satisfactory service " in a land or ship station open to general public service, at least six months of " which must have been served during the last twelve months of the license period.

" However, holders of commercial extra first-grade licenses now employed as " radio inspectors, radio instructors, or in similar occupations requiring exceptional " qualifications where the duties require the testing or demonstrating, or otherwise " using commercial radio apparatus and the telegraph codes, may be issued renewals " of their licenses without re-examination, provided, in addition to the above, they " can show satisfactory evidence of such service covering a period of eighteen months " out of the two-year license period. Where the applicant has not used regularly " the telegraph codes, he will be given the code examination required in the original " examination or, if he has used only one code, he will be examined in the code not " used.

" The service record shown on the licenses must be transcribed on Form 756.

" The license may be marked ' Expired ' in red across the face and returned " to the operator, if desired. The action taken should be noted on Form 756.

" Where the record on the reverse side of the license does not show the service " performed, the evidence submitted as proof of such service must be transmitted to " the United States Bureau with Form 756.

" Transcriptions of code tests must be submitted to the Bureau."

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Wireless Telegraphy In the War

FIGHTING THE U-BOATS.

THE thrilling despatches, if such they may be called, which have recently appeared in the Press from the pen of the well-known writer, Mr. Alfred Noyes, have received more attention than most war despatches owing to the fact that their publication has been authorised by the Admiralty. The story was issued to the Press in four portions, and dealt with German submarines and some of the methods adopted by the Allies to combat their ravages. The part played by wireless telegraphy in the elaborate system of defences appears most plainly. Not the least attractive feature of these despatches is the graphic way in which Mr. Noyes deals with his subject. Speaking of the attack on the American steamship *Gulflight*, to which reference has already been made in these columns, the writer quotes the words of the skipper of His Majesty's Drifter *Contrive*. Here is a portion dealing with wireless telegraphy: "Ten minutes later I saw the patrol vessels racing up "for all they were worth, and one of these vessels took half the crew, two of whom "were drowned. The captain of the *Gulflight* died of shock. Soon the four patrol "vessels were on the spot; and three of these vessels put men aboard with wires "in double quick time. The fourth—a big trawler with wireless (which I now know "in naval language as a 'trawler leader') steamed round and round in the vicinity, "keeping a careful watch. In less than two hours the *Gulflight*, her 'Stars and "Stripes' still flying above water, was being towed at a good speed to a port with "the trawlers in attendance." In the third part of Mr. Noyes's article we again have reference to wireless, this time relating to the adventure of the steamship *Van Stirum*, which, upon being attacked, sent out a distress call: "*Van Stirum* "chased by two submarines, position critical, firing shots, and gaining on us." The race between the submarines and the unfortunate vessel was very uneven, and after a while one of the shells brought down the wireless aerial. This, a lucky shot for the Germans, cut the vessel entirely off from the outside world. Such, however, was the vigilance of the patrol craft that although the *Van Stirum* never raised an answering call (her aerials having been shot away), yet the patrol steamers heard the cry and sped to her assistance. Rapid interchange of wireless communication between the patrols of trawlers and other craft also brought three British destroyers on the scene, but by this time both submarines had submerged and bolted.

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HELLENIC COMPLICATIONS.

Events in Greece towards the end of August and the beginning of September were changing and turning with such dramatic suddenness that very little surprise was occasioned on the announcement that the Allies had taken over the control of the posts, inland telegraphs and wireless communications. At this time it should be remembered that the useful wireless station at Salonica had been held by General Sarrail for some period; under the new *régime* the powerful Marconi station at Athens, capable of radiating and receiving messages over a large range, the stations on the islands of Salamis, Syra and Thasos, and some other installations recently erected, all fell into the hands of the Allies, who will doubtless make excellent use of them.

Readers of our magazine whose memory extends back to the days of the *Marconigraph* will recollect the interesting article from the pen of Mr. Harold Watterson, in the issue of April, 1912, relating to the discovery of ancient vases at the Athens Marconi station. During the excavations for the foundations of that place a number of valuable specimens of Grecian pottery were found, together with skulls and other remains.

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OUR LATEST ALLY.

With the entry of Roumania into the European conflict one more link in the chain of wireless—perhaps we had better say one more section of the network of

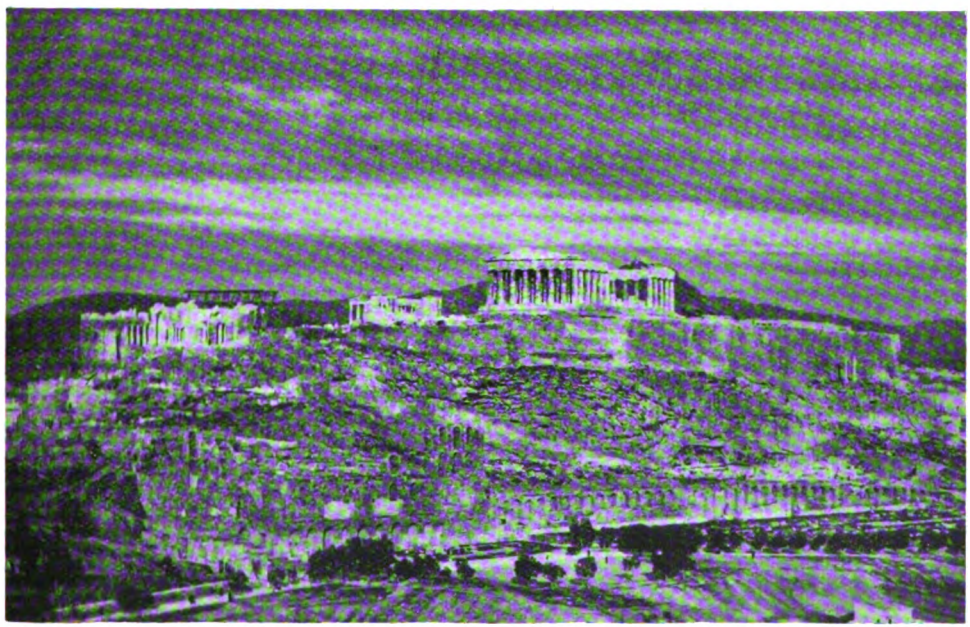

Photo by] [*R. A. Bennett*

A VIEW OF THE ACROPOLIS, ATHENS. AT ATHENS THE GREEK GOVERNMENT POSSESSES A POWERFUL MARCONI STATION, WHICH HAS NOW PASSED UNDER THE CONTROL OF THE ALLIES. STATIONS AT SALAMIS, SYRA AND THASOS HAVE ALSO BEEN TAKEN OVER BY THE BRITISH AND FRENCH FORCES.

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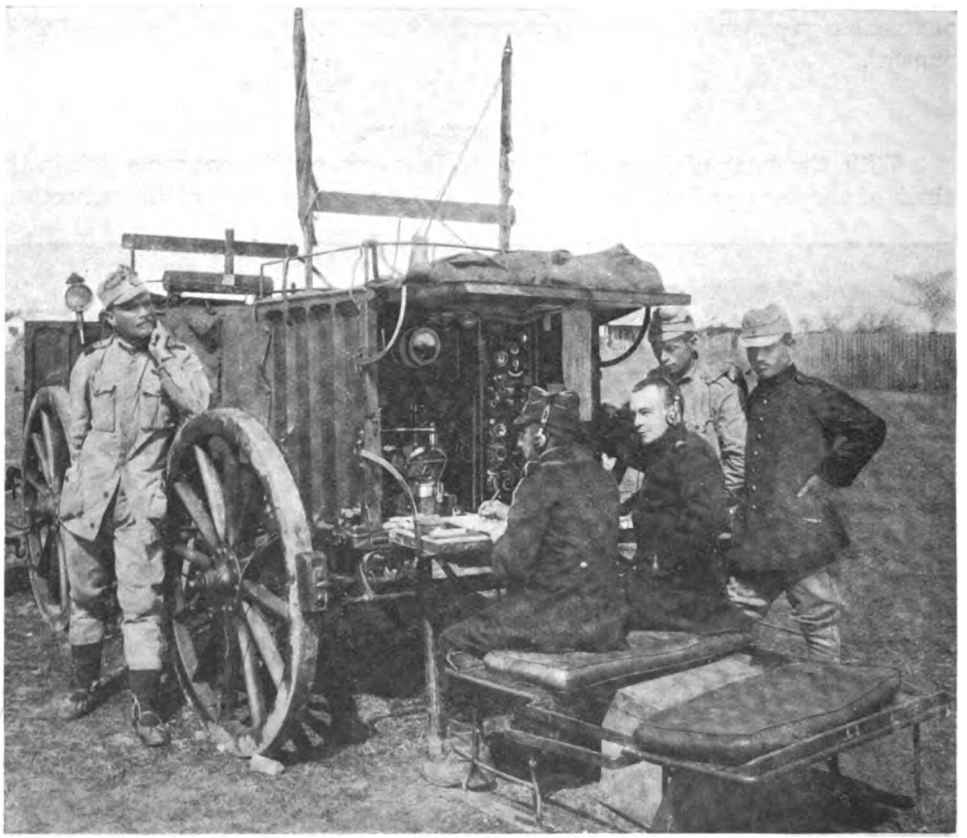

TWO PHOTOGRAPHS OF ROUMANIAN FIELD WIRELESS STATIONS. ABOVE, THE ARRANGEMENT OF THE PORTABLE MASTS AND THE APPARATUS CART CAN BE SEEN; BELOW, ROUMANIAN OPERATORS (ONE WITH HIS CAP ON!) ARE SEEN WEARING THE TELEPHONES AND RECEIVING MESSAGES FROM A DISTANT STATION. NOTE THE COMPACTNESS OF THE APPARATUS (MARCONI SYSTEM).

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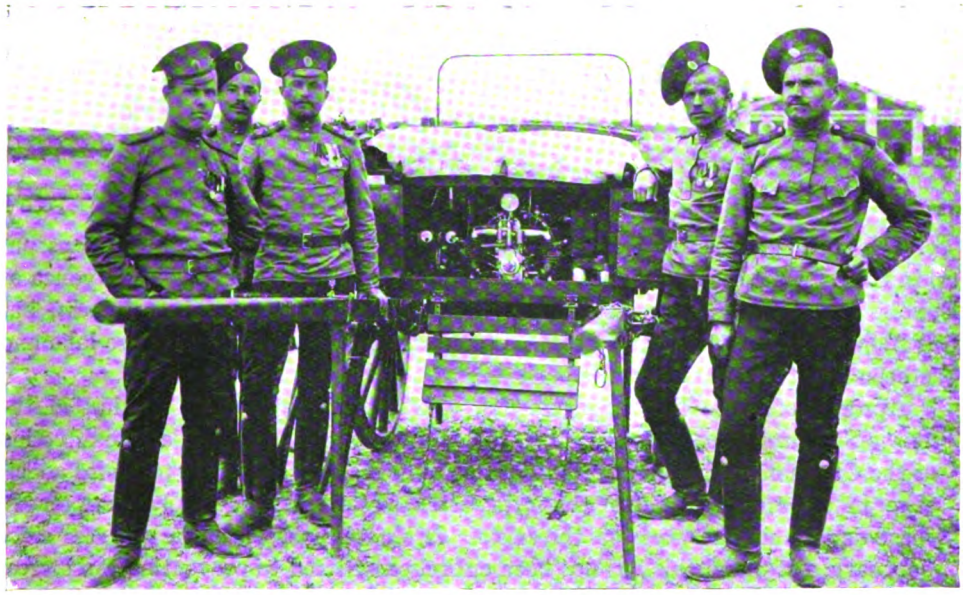
this communication—will be available to strengthen the Allies in their progress towards victory. Our new Balkan Ally possesses at Bucharest a powerful radio-telegraphic installation by which the Army Headquarters will be enabled to keep in closest touch with members of the Staff in the field, and, what is equally important,



RUSSIAN PORTABLE WIRELESS APPARATUS. MANY OF THESE STATIONS ARE WORKING IN CONJUNCTION WITH THE ROUMANIAN SETS SHOWN ON THE PREVIOUS PAGE. THE ABOVE ILLUSTRATION SHOWS THE PETROL ENGINE CONNECTED TO THE TRANSMITTING DYNAMO.

with the Allies at London, Paris, Rome and Petrograd, not to mention General Sarrail at Salonica. With portable stations the Roumanian Army has been well provided for some years. Now that the Russians have advanced and united with the Roumanians the field stations of both armies will be invaluable.

There is perhaps no harm, now that it has been announced that the Allies have been arming Roumania for some time, in stating that the Marconi Company at the same time were making portable wireless stations for that country. These are now ringing out their messages from the battlefield on the plains of Transylvania, under the care of Roumanian operators.

We are able to reproduce in these pages photographs of Roumanian and Russian portable apparatus, which it will be seen is compact to the last degree. It may well be that the actual installations shown are now interchanging telegrams; in any case, the sets in use are practically identical with those shown.

* * * * * *

Exit a Sunspot.

Dar-es-Salaam, the capital of the district known in pre-war days as German East Africa, and the last town of importance in that colony to fall into the hands of the

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British, possessed a powerful and, for the Germans, highly useful wireless station of the conventional Telefunken type. To this station in the happy days of peace the German merchantmen trading on the eastern coast of the great continent were accustomed to send messages announcing the time of their arrival, and many British operators will remember the piercing "mosquito" note of its spark. Five days after the outbreak of hostilities a British warship, by a few happily placed shells, blew up the station and quenched its spark for ever. Many of us will wonder why twelve months had passed before the town itself was occupied, but in the words of an American advertisement—"There's a reason!"

* * * * * *

The station at Dar-es-Salaam was only one of several which the Germans put up in their East African Colony. On the western shore of Lake Victoria Nyanza at Bukoba they had another installation of considerable power and usefulness, but this soon fell under the gunfire from British armed ships operating on the lake and has been silent for many months.

Apropos of these lake engagements, a Naval correspondent, writing in the *Evening Standard* recently, says: "In the operations the Navy, under the direction "of the Commander-in-Chief of the Cape Station, has also been able to afford assist- "ance in the offensive against the forts, wireless stations, and supply bases on the "coast and in similar work on the lakes. A blockade has been in progress since "February, 1915, and this has not been entirely restricted to preventing the ingress "of military supplies."

We can well imagine the wireless operator on the British vessel listening to the working of the station on the lake shore and then suddenly noticing a dead silence when a shell from our ship "gets home."

Photo by] [*Topical.*

THE FIRST GERMAN WIRELESS STATION AT DAR-ES-SALAAM. SOME TIME AFTER THIS STATION WAS ERECTED THE GERMAN AUTHORITIES REPLACED IT BY A MORE MODERN STATION WITH A TALL STEEL MAST AND UP-TO-DATE APPARATUS. THE BRITISH SMASHED IT TO PIECES BY GUNFIRE EARLY IN THE WAR.

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Photo by] [De Lord, Zanzibar.

A NATIVE BAZAAR, OR SUK, AT ZANZIBAR.

Incidents in Zanzibar

Some Experiences in a Wireless Operator's Life

By F. L. DENNIS

It was a dull, cold day in December, 1914, when I received instructions to prepare to proceed to Zanzibar. The thought of being again *en route* to a spot where the sun shines was the most cheerful part of the proposition, but I was to experience sun in more ways than one before my stay in the East African Protectorate terminated

It was soon evident after the commencement of hostilities that Zanzibar wireless station was to play an important part in the operations. The German station at Dar-es-Salaam, however, did its best to " jam " our communications. This went on till one of His Majesty's ships fired a few 6-inch shells on it, after which the *Königsberg* was the only station to interrupt. X's in this part of the world are bad at all times, but between April and September the atmospherics roll in between sunset and sunrise like a veritable bombardment. The aerials being of a balanced-capacity type, care had to be taken during bad storms to earth the aerial or switch in a high-resistance lightning arrester. Most of the operators had shocks

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at different times, the cure for which was, in their opinion, a day off. This caused a growl amongst those who had to do their watch, but I found everything comes to those who wait, even a friendly X. The niggers thought the lower wires of the aerial a fine clothes line till they happened to be hanging out at the same time as the operator was transmitting, and then—well, some of the attitudes I have seen them in would do justice to a comic artist. Once we ran short of crystals, so hunted the island over for some pyrites. Some pieces gave very good results, but, being rather soft, soon lost their points through X's. I found that a good carborundum crystal of fair size, on a steel disc, stood up in these fierce atmospherics better than any other combination known out here. A point of interest lies in the fact that this is one of the few places where wireless has been used for communication between Britain and her enemies. Previous to the destruction of the *Königsberg* that ship used to send messages to the Admiral saying they wished to send letters from British prisoners of war if we would call for them. The Admiral used to reply that he would call, bringing letters for British prisoners of war and also to fetch letters of German prisoners interned in India. At times some quiet slaves used to come from the *Königsberg*. In reply to our invitation to come out and fight, she said she was "always at home when we chose to call." It is the custom of the British never to refuse a polite invitation, so the *Severn* and *Mersey* called, with what result you all know. On one occasion after we had done a little "strafing,"

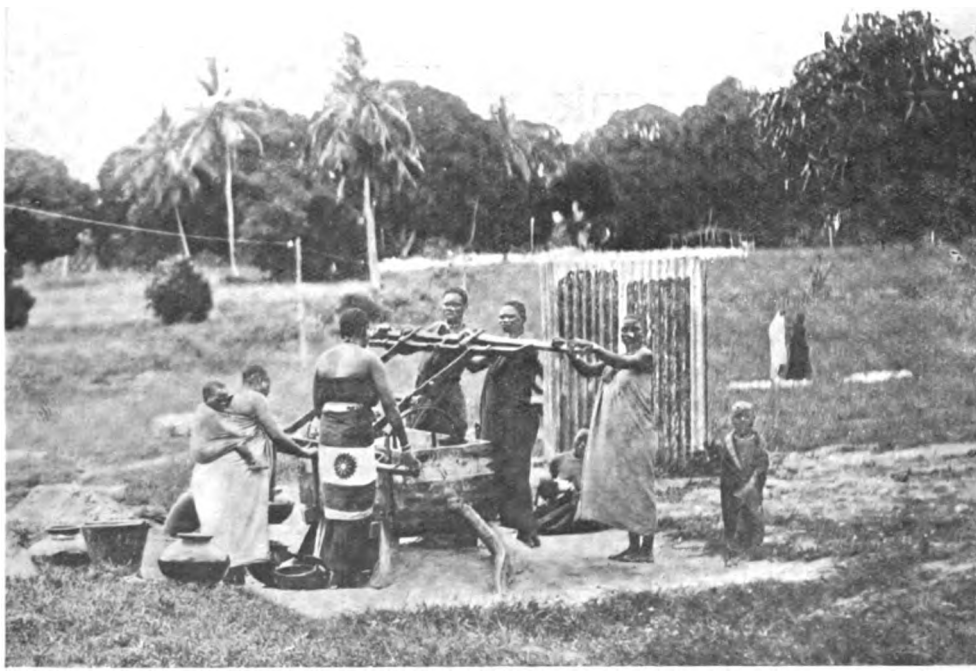

Photo by] [*De Lord, Zanzibar.*

NEGROES MAKING "TEMBI" (NATIVE BEER). THE CONSUMPTION OF THIS BEVERAGE HAS NOW BEEN PROHIBITED.

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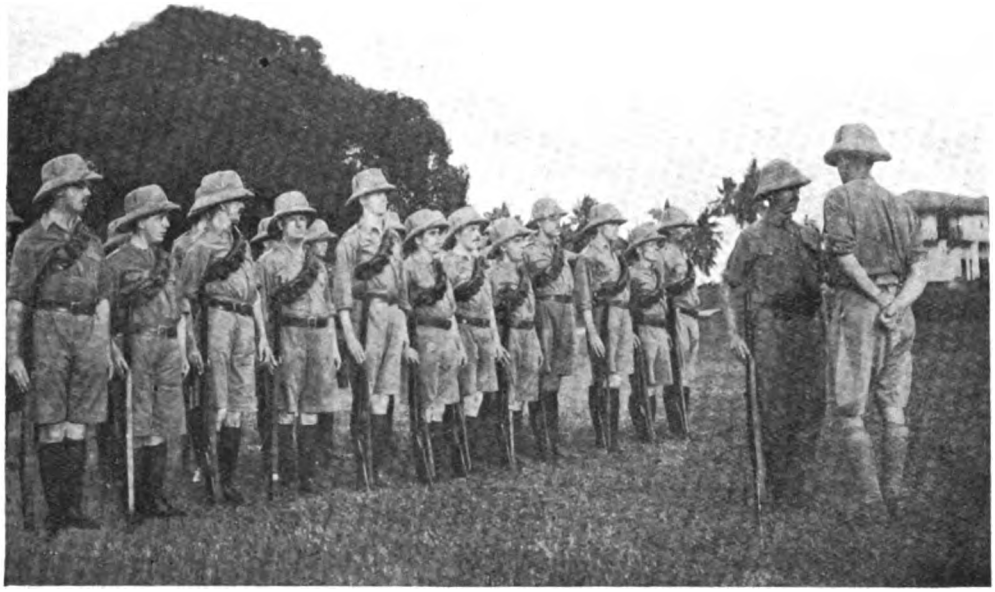

ZANZIBAR DEFENCE CORPS. THE AUTHOR OF THIS ARTICLE IS THE SECOND FIGURE FROM THE LEFT IN THE FRONT RANK.

the Telefunken note came through saying, " Result of your bombardment, one monkey and fourteen cocoanuts."

I should like now to quote one or two incidents that happen to all officials who are " carrying on " in these outposts of Empire. As is usual in this part of the world, the staff ranges from the ordinary African negro, through the various Arab and Indian castes, to the pure-white official from home : the last being rarely met with. On arrival in Zanzibar it did not take long to concur in the general opinion that the climate was exceedingly bad. A resident of some years' experience informed me that there were two seasons : one hot, and the other " d—— hot." I had not been many days in the Protectorate when I was " raked in " as a member of the Zanzibar Volunteer Defence Force, along with the other British residents on the island. Lieutenant-General Smuts had not arrived, and at this time things were not too rosy in East Africa, so we were doing our bit in helping to hold on. Most of our spare time was spent in drill ; and in order to appreciate what sun and heat are like, combined with a Turkish bath humidity, I should advise a visit to Zanzibar and a couple of hours' field exercise in full marching order. Our stations and defences were guarded by companies of the King's African Rifles ; I might mention that there are no better coloured fighting soldiers than the members of this famous regiment. Officered by men picked from home, they are a credit to British rule and civilisation.

To all who have had dealings with oil engines in the tropics the question of lubricating is of the highest importance. For various reasons I had to use a light

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black cylinder oil in place of the brown oil previously used. Now, one of the nigger engine drivers when the old oil gave out had a look round the store and saw only black oil. In his mind this could not be right, so he got hold of a drum of linseed oil and, as it looked the same colour, started to use this. The kicking and back-firing from the engine nearly woke the island till the bearing "chewed out." He now started up the next engine, which developed the same trouble, so the operator shut down and telephoned me. The second engine driver could not stand two engines going wrong at the same time, so he bolted. It was a clear case of the "shitarn" or devil. The "shitarn" in this part of the world involves a very serious question, and is not to be ignored. It got so serious here at one time that it threatened to upset the whole station, for no messengers could be induced to take messages from the station to the town. The "devils" were bound to be met on the road. I say devils, for by now their number had increased. Even some of the Indians began to think they could see things, so I thought the question needed investigation. The kindly old Arab judge, with whom I had a chat in the Sultan's Court, was just as amused as I was over the matter, but he advised me to quiet the folk by calling in the "medicine" man to chase the ghosts away. I told him that three had previously tried without success, but if he sent his pet charmer along I would be pleased to see what he could do. True enough, the "native doctor" came the next day, and decided it was a case for the killing of a goat and ten chickens. I could see this was going to be an expensive business for me, but, however, the ceremony took place, and after every nigger had eaten till he could only sleep afterwards, the medicine man came and told me the devils had been chased, and demanded five rupees "backsheesh." He got one rupee and the toe of my boot, and was told

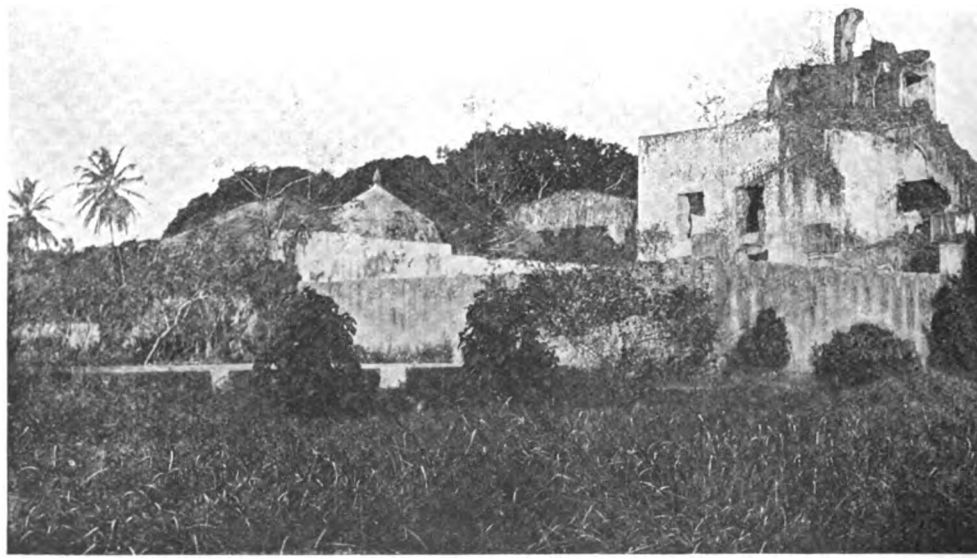

Photo by [*De Lord, Zanzibar.*

RUINS OF THE OLD PALACE OF A FORMER SULTAN OF ZANZIBAR.

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Photo by] [*De Lord, Zanzibar.*

THE LOCAL TRAIN FROM ZANZIBAR PASSING THROUGH THE JUNGLE.

to betake himself off. The same evening I met the Arab judge again, and gave him an account of the proceedings. He smiled in his kindly way, for he was noted for his sense and reason in dealing with purely native matters. He whispered a few quiet instructions to me in the name of "Allah, the Compassionate, the Merciful," gave me a quiet handshake and the parting Arab salute "Onahari," touching his forehead and breast over the heart with the tips of the fingers of his right hand. These quiet salutations in the East mean much. The result was the next day I bought a new "kiboko," called the boys together, and told them the devils had been chased.

One of the windows of Zanzibar Cathedral bears underneath an inscription, an extract from which reads: "To the memory of Livingstone and other men good and true," and a little farther along is a tablet to one of the officers who lost his life on H.M.S. *Pegasus*, sunk in Zanzibar Harbour by the *Königsberg*, in the early days of the present war. No less "good and true" are those other men, amongst whom must not be forgotten the wireless operators who, in various spheres of activity, carry on without a break in all kinds of weather, and amid the ravages of fever, the watch of empire. Many of these men in civil life are operators in the mercantile marine, but they are now doing their bit amidst the tropical scenery of Zanzibar.

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NOTES OF THE MONTH

WILL the Secretaries of all amateur societies which have not been suspended owing to the present war kindly forward full particulars of their societies to the Editor, in order that suitable notice may be inserted in the 1917 edition of the *Year Book of Wireless Telegraphy and Telephony*?

* * * * * *

The report of the Advisory Committee for Aeronautics for the year 1915–1916 states, in so far as meteorology is affected, that the experimental work of the year has mainly concerned arrangements for the automatic recording of lightning flashes, and ascertaining by wireless telegraphy the position of distant thunder storms, with the object of giving warning of their approach to those interested. The Admiralty have arranged for the co-operation of the Naval Wireless Department, and the assistance of observers of weather in various parts of the country has been secured.

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In the day engineering college of the Northampton Polytechnic School, London, full day courses in the theory and practice of civil, mechanical and electrical engineering commence on October 2nd. The courses in civil and mechanical engineering include specialisation in automobile and aeronautical engineering, and those in electrical engineering include radiotelegraphy. The entrance examination takes place on September 26th and 27th. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examination. The courses include periods spent in commercial workshops and extend over four years. They also prepare for the degree of B.Sc. in Engineering at the University of London. In the technical optics department there are full and part-time courses in all branches, in specially equipped laboratories and lecture rooms. An Aitchison Scholarship (value £50) will be offered in this department at the entrance examination. Particulars as to fees, dates, etc., can be obtained at the Institute or on application to the principal, Dr. R. Mullineux Walmsley.

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The session 1916–1917 of the Royal Technical College, Glasgow, began on September 26th. The diploma of the college is granted in civil, mechanical and electrical engineering, mining, naval architecture, chemistry, metallurgy, etc. There are also full courses of instruction in the schools of navigation and wireless telegraphy, and both day and evening classes are held. The diploma courses extend over three or four sessions, and the average fee is £12 12s. per session. The college is affiliated to the University of Glasgow, and the degrees of the university in engineering and applied chemistry are open to its students. Prospectuses may be obtained from the Director, and the calendar is published at 1s. (post free 1s. 4d.).

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Naval and Military Wireless Telegraphists

Their Status and Conditions of Training

In August, 1915, in response to the demand made by a large body of correspondents, we published an article under the title of "How to Become a Wireless Operator." The subject-matter was mainly confined to civilian employment, but the interest taken in the wireless branches of the fighting services has induced us to deal with this side of the matter, and we trust that the following remarks will be found interesting not only by those who want to make practical use of the particulars given, but also by the much larger public who desire to take an intelligent interest in the gallant Britishers who have won so much distinction in this sphere of warfare. Necessarily, there are some particulars which it is undesirable in the public interest to publish; otherwise we have endeavoured to make the information given as complete as possible.

The Editor takes this opportunity of saying that nothing gives him greater pleasure than to be of practical service, either to young men who desire to consider the question of a wireless career for themselves, or parents who contemplate the possibility of putting their sons into the way of following wireless telegraphy as a career. He will at all times be pleased to answer questions as far as possible through the medium of the Magazine.

We purpose taking the two great branches of the King's fighting forces and dealing with them *seriatim*, so that our attention is first directed to the Navy.

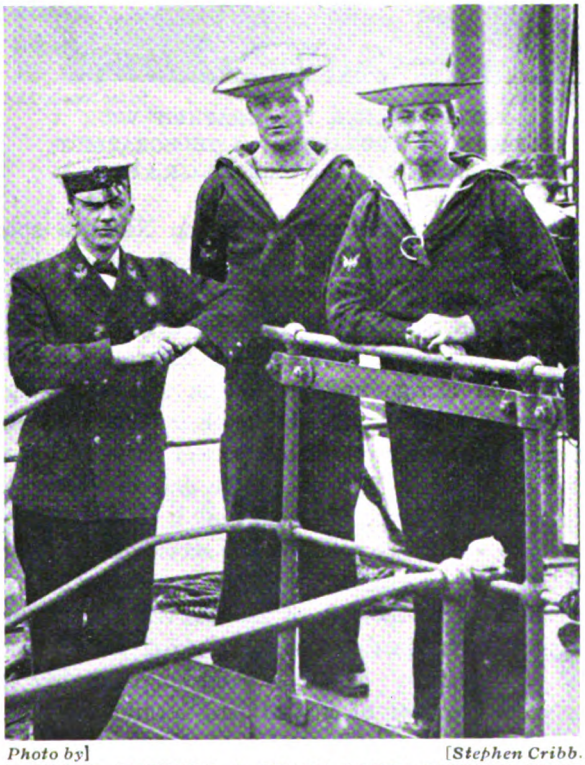

Photo by] [*Stephen Cribb.*

A GROUP SHOWING A CHIEF PETTY OFFICER TELEGRAPHIST, A TELEGRAPHIST, AND AN ORDINARY TELEGRAPHIST.

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Photo by [*Stephen Cribb.*

A PETTY OFFICER TELEGRAPHIST WITH A LEADING TELEGRAPHIST, A TELEGRAPHIST, AND AN ORDINARY TELEGRAPHIST.

RADIO-TELEGRAPHISTS IN THE NAVY.

Wireless operators serving in this branch of His Majesty's service may be classified under three headings :—

(1) Active Service Ratings.
(2) R.N.R. Ratings.
(3) R.N.V.R. Ratings.

We will consider them in order.

Active Service Ratings.

(1) The British Navy has always preferred "catching them young." An ancestor of the present writer fought at Trafalgar on board the *Victory* as a midshipman of fourteen At the present day lads are received on board training ships and establishments at the age of sixteen, and it is not possible for any boy entering the regular service of the Navy to specify as to the particular object of his employment that he shall devote his years of service to wireless telegraphy. He must enter in the regular way and take the general course of instruction, enlisting for twelve years' continuous service, with an optional extension of ten years. Certain lads are selected from those deemed suitable by the officer in charge and trained in signalling, one of the branches being radio-telegraphy. After completing their course in accordance with the Service regulations, they enter upon their career as *boy telegraphists*, receiving the wage of 7d. per day. They then rise to be *ordinary telegraphists*, and their pay is increased to 1s. 3d. per day. The next rank is that of *telegraphist*, whose pay starts at 1s. 11d. and rises after six years' man's service to 2s. 2d. per day, if he has not previously been rated as leading telegraphist. The rating of *leading telegraphist* comes next in order, with the pay of 2s. 6d., rising after one year's service (if he passes the approved standard) to 2s. 10d. After this, promotion means entry into the ranks of petty officer. Those who desire to qualify for this promotion must undergo a special course of instruction, terminating in a stiff examination. As far as wireless telegraphy is concerned, the junior rank is *petty officer telegraphist*, whose wage amounts to 3s. 4d. per day, with an increase (if recommended by the Commanding Officer) after one year's service of 3s. 8d., and after three years of 4s.

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(A.) BADGE WORN BY PETTY OFFICER TELEGRAPHIST AND CHIEF PETTY OFFICER TELEGRAPHIST.

These men may qualify (by service) for the next rank and rise to become *chief petty officer telegraphist*, attaining the scale of pay of 4s. 4d. per day, rising to 4s. 7d. after three years, and 4s. 10d. after six years' service. The method by which petty officer telegraphists gain promotion to the rank of *warrant telegraphists* is by securing the approval and recommendation of their Commanding Officer and selection by the Admiralty, besides undergoing a further special course of instruction.

Royal Naval Reserve Ratings.

(2) Men may be engaged (between the ages of twenty-one and forty) who hold a first-class Postmaster-General's certificate, and who are experienced in wireless telegraphy. They must qualify for the Royal Navy (over and above their present qualifications) by a sea experience of not less than six months, and then enter as *wireless telegraph operators of the second class*, ranking as chief petty officers and receiving pay at the rate of 3s. per day, rising after a minimum of two months' service in the Navy (if passed and recommended by their Commanding Officer) to become *wireless telegraph operators of the first class* with the pay of 5s. daily. Certain of these men have been selected for the rank of warrant telegraphist, R.N.R. Promotion to warrant rank may be secured by men selected from amongst the wireless telegraph operators of the first class, and it must be always remembered that there are no warrant telegraphists, R.N.V.R. Any promotion from the R.N.V.R. men to warrant ranks involves transference to the R.N.R. A case in point occurred towards the beginning of the war when certain operators in civil employment received the rank of warrant telegraphists, and were thereby incorporated with the R.N.R., instead of being enrolled in the ranks of the R.N.V.R.

(B.) BADGE WORN BY LEADING TELEGRAPHIST.

(C.) CAP BADGE WORN BY WIRELESS MEN OF THE ROYAL NAVAL RESERVE.

Royal Naval Volunteer Reserve Ratings.

(3) R.N.V.R. wireless operators are men who, being eligible for military service and having enrolled in the R.N.V.R., are selected to serve in the Navy as wireless telegraphists. They receive their training in naval establishments. During this probationary period their remuneration is 1s. 3d. per day, and they enter the service as *ordinary telegraphists* with a pay of 1s. 3d. per

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day, rising to the ranks of *telegraphist* (1s. 11d. to 2s. 2d. per day) and *leading telegraphist* (2s. 6d. to 2s. 10d. per day). The question of higher ranks does not occur in their case; for the period of the war is not likely to extend their service to a sufficient length for such promotions to come within their range.

There is a further section of the R.N.V.R., consisting of wireless engineers and operators in private service before the war began, some of them stationed at home and some abroad. These men are the *personnel* of existing stations which have been taken over complete by the Admiralty. They are called the Shore Wireless Section of the R.N.V.R. There have been of late very few additions to their number. With the exception of certain operators to whom reference has already been made at the close of our remarks above concerning the R.N.R. ratings, these normally civilian wireless operators admitted to Government service for the purpose of the war have been included in the R.N.V.R., S.W.S. ratings. In the case of important stations the engineers in charge have received the rank of lieutenant R.N.V.R., their assistants ranking as sub-lieutenants. In the case of the less important stations, where only a single engineer is employed, he ranks as sub-lieutenant. Operators attached to such stations have become petty officers R.N.V.R., S.W.S., whilst the principal operators rank as chief petty officers. With regard to these shore engineers and operators the pay is regulated in accordance with the special circumstances attending each case, and no general rule can be set forth.

A similar procedure has been followed in the case of the Wireless Staff of the British P.O. In normal times of peace an ever-increasing number of P.O. employees are engaged on radio-telegraphic duties, and these are for the most part recruited from officials already employed in other departments of the Post Office. As soon as the war commenced this normal peace establishment of the G.P.O. Radio Staff was largely increased by the addition of temporary wireless operators drawn from the Inland Telegraph section. Thus augmented, the G.P.O. Wireless Staff has been, almost without exception, included in the special Shore Wireless Section of the Royal Naval Volunteer Reserve, whilst those who are not so enrolled are engaged in special work for the War Office.

Under the present war conditions, then, Commander Loring, R.N., Inspector of Wireless Telegraphy to the Post Office, stands as immediate senior officer to a number of Lieutenants and Sub-Lieutenants who assist in the control of the Post Office wireless service. The operators enrolled have all received the rank of Petty Officers, and in some cases Chief Petty Officers, their pay remaining on a normal civilian basis.

General Remarks.

All men, whether they belong to the R.N., R.N.R., or the R.N.V.R. sections, have to pass the established medical examination. The R.N.R. and R.N.V.R. men are allowed to wear glasses, the R.N. are not. The R.N.R. and R.N.V.R. ratings are entered (as far as the vast majority are concerned) for the duration of the war only.

With regard to *promotion* from non-commissioned to commissioned ranks, it may be pointed out that the most senior Warrant Officers in the Navy are called Chief Warrant Officers, and from these a few are from time to time selected for commissions as Lieutenants. The system of promotion to mates forms the main avenue by which the younger men can obtain commissions

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as Sub-Lieutenants, whence the majority of them become eligible for advancement for all ranks in the usual course.

With regard to *badges* we append three illustrations :

(A) The badge worn by Petty Officer Telegraphists on their right arm. This same badge is worn by Chief Petty Officer Telegraphists, only carried on the collar instead of the right sleeve.

(B) The badge worn by leading telegraphists on their right arm is the same as the badge worn by telegraphists, with the difference that the latter carry only the star above the winged sign. Ordinary telegraphists and boy telegraphists wear the winged sign only with no star either above or below. In each of the three cases leading telegraphists, telegraphists and ordinary and boy telegraphists, the badges are worn on the right sleeve.

(C) The cap badge worn by wireless men of the R.N.R.

There are no distinctive badges allotted to wireless men of the R.N.V.R., who wear the same badges as the Active Service men.

(To be continued.)

Chief Operators

THE first duty of a chief operator is to see that the operators under him perform their obligations towards the company, and keep the business moving. In the performance of this duty chiefs employ different methods of attaining the end, their object being to get the work out of the men with the least friction. Here is where a knowledge of human nature becomes of practical value. Some chiefs, unfortunately, become unpopular because of their too intense insistence in keeping business moving, which is irritating to many natures, and the moment an operator becomes irritated or annoyed in his work, his efficiency is at once lowered. Chief operators should make a special study of human nature so as to enable them to get the full amount of work out of each individual without incurring any ill-will. One rule will not apply to the mass ; each case requires different treatment, just as in a case of illness. The disposition of the patient and other factors must be considered in order to proceed to bring about a cure. So with a man at work. Stern discipline and firmness is necessary in some cases, and in others gentleness will accomplish the best results.

Every chief operator, no doubt, has given much thought to the problem of getting the best work out of the men, but the principal factor of success in every case is a consideration of individual characteristics, and the application of proper means to achieve the desired result.

(From the " Telegraph and Telephone Age.")

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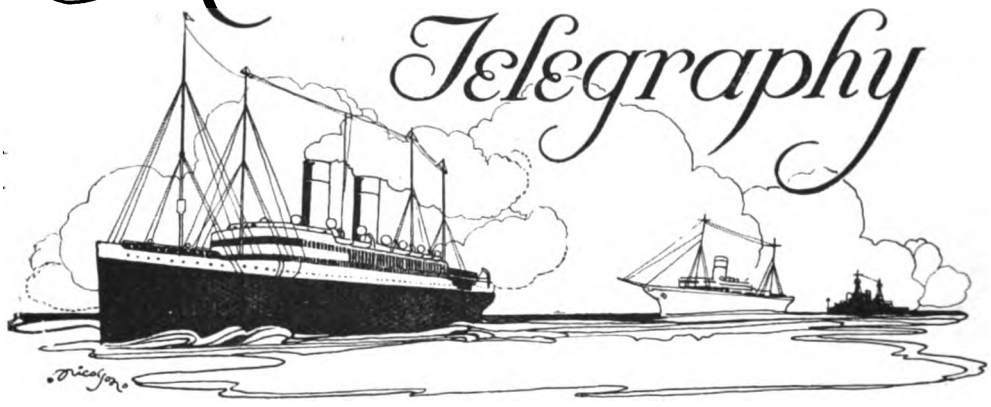
Maritime Wireless Telegraphy



Spanish Ship Sunk.

A wireless message recently came to hand from San Sebastian stating that a Spanish ship had been torpedoed, either by an Austrian or a German submarine. No further details have been received, and it is, therefore, presumed that all hands have been lost. A subsequent message from Paris stated that the scene of the tragedy was in the Mediterranean, and that it was a German submarine which was responsible for the act.

* * * * * *

Seized or Sunk?

The Stockholm *Tidning* reports that the German ore steamer *Desterro* has probably been either seized or sunk by a submarine. A wireless message stated that the steamer was chased by a submarine. The vessel had a pilot on board, from whom later nothing could be heard. According to a further wireless message received by a Swedish station, another German ore steamer was captured.

* * * * * *

A Steamer Afire.

Whilst the steamer *La Blanca* was proceeding in the South Atlantic Ocean a fire broke out. She immediately sent a wireless telegraph to Monte Video announcing the occurrence and stating that she was proceeding with all speed to that port. She subsequently wirelessed that she was badly on fire and would require help immediately on arrival. When she reached the port the fire apparatus was brought into play and the flames were speedily subdued.

* * * * * *

Ships' Motor Life-Boats.

Nearly all large passenger ocean liners now carry motor life-boats fitted with wireless telegraphic apparatus in addition to the original hand-propelled boats. There has recently been completed at Saltney a double-ended motor life-boat for one of the liners of the Canadian Pacific Ocean Service, Ltd. She is constructed on the double skin diagonal plank system, which gives great strength and stiffness. The propelling machinery, which is installed amidships, is a three-cylinder 25 B.H.P. paraffin set, fitted with petrol starting and coupled to a reverse gear. Wireless telegraphy is fitted in a small cabin directly forward of 'midships.

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British Association for the Advancement of Science

MEETING AT NEWCASTLE.

In Section G (Engineering) of the British Association Meeting on Thursday, September 7th, two papers on Wireless Telegraphy were read.

The first paper was contributed by Professor G. W. O. Howe, and was entitled "The Calculation of the Capacity of Aerials, including the Effects of Masts and Buildings." Our readers will remember that this is a subject to which Professor Howe has devoted considerable attention, his paper on similar investigations read at last year's Meeting being reproduced in The Wireless World for October last. A full reprint of this year's paper will be found on another page.

Upon the conclusion of the paper a short discussion was opened by Mr. Campbell Swinton, who expressed his appreciation of the admirable way in which the Author had in his previous papers gone on from step to step, from the elementary form discussed at Sydney to such complicated arrangements as were dealt with in the

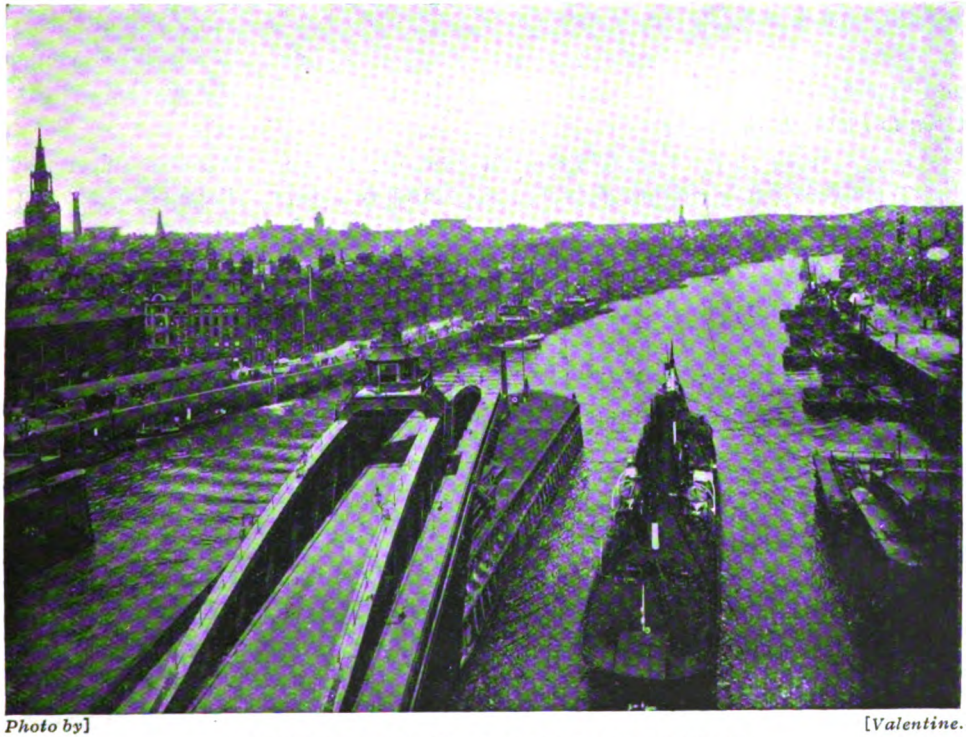

Photo by] [*Valentine.*

A VIEW OF NEWCASTLE, WHERE THE BRITISH ASSOCIATION MEETING WAS HELD THIS YEAR.

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paper read that day. Professor Marchant, of Liverpool University, also spoke in praise of the paper.

The second paper dealt with "Some Characteristic Curves of the Poulsen-Arc Generator," and was read by Mr. N. W. McLachlan. This we hope to reproduce in full in our November issue. The brief discussion on the paper was opened by Professor Marchant, who called attention to the non-inductive resistance employed by the Author in his experiments. Professor Howe also expressed great interest in the Author's work.

Patent Record

5202. April 10th. H. Munro. Method of determining direction from which sounds proceed and the distance at which they originate.

5391. April 12th. Allmanna Svenska Elektriska Aktiebolaget. Continuous current generator. (Convention date, Sweden, May 5th, 1915.)

5445. April 13th. E. C. R. Marks (for Goldberg). Electrical control apparatus.

5458. April 13th. Société Française Radio-Électrique. Wireless Telegraphy and Telephony. (Convention date, France, December 28th, 1914. Patent No. 100,281. *Open to Public Inspection.*)

5466. April 13th. Société Française Radio-Électrique. Wireless Telegraphy and Telephony. (Convention date, France, March 1st, 1915. Patent No. 100,282. *Open to Public Inspection.*)

5471. April 13th. Société Française Radio-Électrique. Wireless Telegraphy and Telephony. (Convention date, France, March 9th, 1915. Patent No. 100,283. *Open to Public Inspection.*)

5631. April 17th. R. F. Bossini and H. R. Wilding. Sound detector.

5634. April 17th. R. F. Bossini and H. R. Wilding. Sound detector and transmitter.

5807. April 20th. A. H. Dykes, W. Duddell, H. W. Handcock and C. Oliver. Distance-operated mechanism and signals connected to electrical supply system.

Share Market Report

LONDON, *September 13th*, 1916.

BUSINESS in the Share Market has been fairly active during the past month and there has been considerable demand for the shares of the various Marconi issues. The closing prices as we go to press are :—

Marconi Ordinary, £3 3s. 9d. ; Marconi Preference, £2 11s. 10½d. ; Marconi International Marine, £2 6s. 3d. ; American Marconi, 19s. 3d. ; Canadian Marconi, 10s. 3d. ; Spanish and General Wireless Trust, 12s.

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The Calculation of the Capacity of Radiotelegraph Antennæ, including the Effects of Masts and Buildings

By PROFESSOR G. W. O. HOWE, D.Sc., M.I.E.E.

Paper read before the British Association for the Advancement of Science at Newcastle, 7 September, 1916

UNTIL quite recently the calculation of the capacity of radiotelegraph antennæ, except in the simplest cases, was looked upon as an impossibility, and one of the leading text-books on the subject stated that, " In the case of multiple-wire aerials, the only way to determine the capacity is to measure it." This is no longer the case, however, and it is shown in this Paper that, even for aerials of complicated design, it is a relatively simple matter to pre-determine the capacity and to calculate the effects of the earth, the masts and anything else in close proximity to the aerial. The accuracy obtainable is more than sufficient for all practical purposes.

The principle of the method employed by the author has already been described,* and in the present Paper the method is extended and applied to a number of concrete examples. Some tests are also described, the results of which indicate the accuracy of the calculated values.

The principle of the method is briefly as follows : It is assumed that the charge is uniformly distributed over the surface of the whole antenna, and the average potential of the antenna under this fictitious condition is then calculated. Formulæ have been worked out by means of which the average potential can be easily determined even in the case of complicated antennæ. The assumption is then made that this average potential differs but little from the actual potential which the antenna would have at every point if the same total charge were no longer uniformly distributed, but allowed to have its own natural distribution.

In the original Paper, read before the British Association at Sydney, formulæ and curves were given for flat multiple-wire antennæ with any number of wires from 1 to 12, and also for four-wire aerials with the four wires at the corners of a square. Formulæ and curves were given for wires meeting at various angles, and it was shown that two equal wires meeting at an acute angle, like the sides of a letter V, have the same average effect on each other as if they were parallel at a distance equal to 0·36 of the perpendicular dropped on one wire from the end of the other. The effect of the earth on both horizontal and vertical wires was considered, and some numerical examples of the application of the method to actual antennæ were given. It was shown that, when applied to an example quoted by

* "The Capacity of Radiotelegraphic Antennæ," Brit. Assoc., Sydney; WIRELESS WORLD, February, 1915. "The Capacity of Aerials of the Umbrella Type," Brit. Assoc., Manchester; WIRELESS WORLD, October, 1915.

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Dr. Louis Cohen (*The Electrician*, February 21st, 1913), the method gave results in good agreement with the measured value, whereas the method described by Cohen himself gave an error of 20 per cent. In September, 1915, the author published formulæ and curves by means of which aerials of the umbrella type can be readily calculated.

In his *Principles of Electric Wave Telegraphy*, Professor Fleming gives a number of measured capacities of actual aerials of various types to serve as a guide in estimating the capacity of any other aerial. Some of these measured values agree fairly well with the calculated values, but others show a wide divergence; it was in seeking to explain these discrepancies that the author was led to devise a method of calculating the effect of masts and buildings. Although the data given with regard to the method of supporting the aerials are too meagre in most cases to allow of accurate calculation, it will be seen that the assumption of probable data leads in some cases to calculated results differing but little from the measured values. The discrepancies are most marked when the aerial consists of a very large number of wires; for instance, "25 vertical (?) wires 0·1 in. diameter, 200 ft. long, arranged fan shape with top ends about 2 ft. apart = 1,640 micro-microfarads." Now, this is considerably greater than the calculated value, even if the wires were everywhere 2 ft. apart and not brought together at the lower end. Unless there is some error in the data, this can only be due to masts or buildings, or some factor which is not mentioned.

In the original Paper the curves and formulæ were not carried beyond 12 wires, and we shall now extend them so as to include this multiple antenna of 25 wires. It was shown on page 859 of *The Electrician* (September 4th, 1914) that the capacity of a multiple-wire antenna with n parallel wires in one plane is given by the formula,

$$C = \frac{16{\cdot}94n}{n\left(\log_e \frac{l}{d} - 0{\cdot}31\right) + \log_e \frac{d}{r} - B} \times 10^{-6} \text{ mfd. per foot,}$$

where l is the length of the antenna, d the distance between adjacent wires, and r the radius of the wire. The constant B is the average value of $\log_e (\underline{n-m} \,\underline{m-1})$ for all values of m from 1 to n. The work of finding this average value is considerably lightened by remembering that $\log \underline{x}$ is equal to $\log \Gamma(x+1)$, the values of which are tabulated in Dale's Mathematical Tables, p. 77. For $n=25$ we get $B=44{\cdot}75$. The values of B for any number of wires up to 25 can be read off the curve (Fig. 1), which is an extension of Fig. 6 in the original Paper. For any value of n greater than 15 it is seen that $B=2{\cdot}44\ (n-6{\cdot}7)$. If, instead of

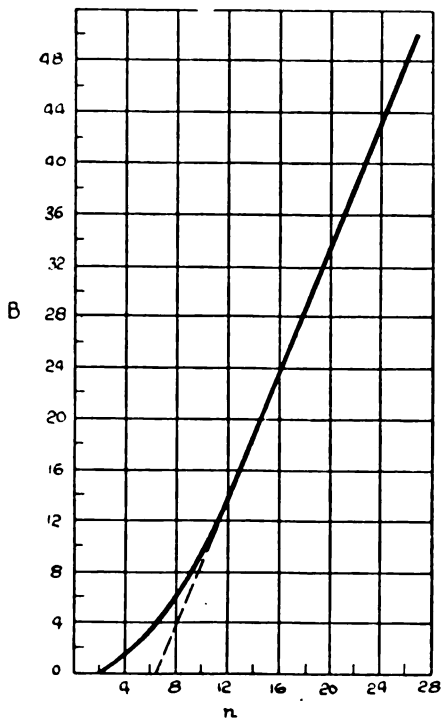

FIG. 1.

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the capacity, we wish to find the average potential of the antenna when uniformly charged with unit quantity per centimetre of wire, we have

$$V_{av.} = 2n\left(\log_e \frac{l}{d} - 0{\cdot}31\right) + 2\log_e \frac{d}{r} - 2B,$$

or if n is greater than 15

$$V_{av.} = 2n\left(\log_e \frac{l}{d} - 0{\cdot}31\right) + 2\log_e \frac{d}{r} - 4{\cdot}88\,(n - 6{\cdot}7).$$

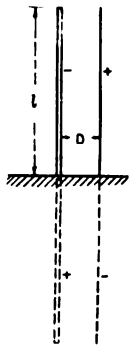

FIG. 2.

Now, in the example quoted above, if the 25 wires had been parallel and 2 ft. apart, we should have

$$\frac{l}{d} = \frac{200}{2};\ \log \frac{l}{d} = 4{\cdot}6;\ \frac{d}{r} = \frac{24}{0{\cdot}05};\ \log \frac{d}{r} = 6{\cdot}16.$$

$V_{av.}$ due to its own charge $= 214{\cdot}5 + 12{\cdot}3 - 89{\cdot}5 = 137{\cdot}3$. The total charge is $25 \times 200 \times 30{\cdot}5 = 152{,}500$, and were it not for the earth the capacity would be $1{,}234 \times 10^{-6}$ mfd. The negative potential of the aerial due to its image in the earth will be approximately $\frac{152{,}500}{200 \times 30{\cdot}5} = 25$, thus lowering its resultant potential from 137·3 to 112·3, and increasing the capacity to $1{,}510 \times 10^{-6}$ mfd.

It was shown in the original Paper that fan-shaped aerials could be calculated as parallel wires with a value of d equal to 0·365 of the actual distance at the widest point (strictly, of the perpendicular dropped from the end of one wire on to the other); hence l/d and d/r should be taken as 274 and 175 respectively. Repeating the calculation with these values, we get a resultant capacity of $1{,}054 \times 10^{-6}$ mfd., whereas that given as the measured value is $1{,}640 \times 10^{-6}$ mfd.

Another actual example for which the measured capacity is given is that of "160 wires, each 0·1 in. diameter and 100 ft. long, arranged conically with bottom ends together 10 ft. above the ground, and top ends 2 ft. apart = 2,685 micro-micro-farads." The circumference of the circle formed by the upper ends of the wires is 320 ft., giving a radius of 51 ft., and since each wire is 100 ft. long it must make an angle of 30 deg. with the vertical. If we assume each wire to have unit charge per centimetre of length, the average potential of any wire

due to its own charge	= 19·55
,, the next wire	= 9·3
,, the 40th wire	= 2·695
,, the opposite wire	= 2·2

By plotting these values, the potential due to any wire can be found, and thus the average value, which is found to be 3·28. Hence, the potential

due to its own charge	= 19·55
,, the other wires	= 521 (= 159 × 3·28)
,, the earth image	= −160 (approx.)
The total potential	= 381

Hence

$$C = \frac{160 \times 100 \times 30{\cdot}5}{381 \times 0{\cdot}9} = 1{,}423 \times 10^{-6} \text{ mfd.}$$

which is only 0·53 of the measured value given for this antenna.

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It has been assumed that each wire is insulated at its upper end. This is improbable, and it is interesting to consider the effect on the capacity of supporting the 160 wires from a horizontal cable of, say, 0·5 in. diameter. This cable will form a circle with a circumference of 320 ft., and since it has five times the diameter of the antenna wires, and is more advantageously placed, it will require a much greater charge per centimetre of length to raise it to the same potential. We shall assume that it has a charge of 12 units per centimetre.

It is necessary now to find the potential of this cable due to the various charges.

(1) The Potential of a Circle of Wire Due to its Own Charge of 1 Unit per Centimetre.

The potential at any point P on the axis of the wire is due (*a*) to the charge on the wire in its immediate vicinity which may be considered linear, and (*b*) to the charge on the remainder of the circle.

(*a*) This may be confined to the wire subtending a small angle θ_1 on each side of P (*see* Fig. 5), and may be calculated as a cylindrical conductor of length $l=2\theta_1 R$. In the present example $R=51$ ft., and if θ_1 be taken as 4 deg., $l/r=342$. The potential at the mid-point $P=2\log_e l/r=11{\cdot}67$.

(*b*) The potential at P due to the remainder of the circle

$$=2\int_{\theta_1}^{\pi}\frac{Rd\theta}{2R\sin\theta/2}=2\left[\log\tan\frac{\theta}{4}\right]_{\theta_1}^{\pi}=-2\log\tan\frac{\theta_1}{4}$$

$$=-2\log\tan 1^\circ=8{\cdot}1.$$

Hence the total potential at P due to the charge on the ring $=11{\cdot}67+8{\cdot}1=19{\cdot}77$. This applies to any circle with $R/r=2450$, and a charge of 1 unit per centimetre. It is interesting to note that if this wire were straight its average potential would be 6 per cent. lower, so that its capacity is decreased this amount by being bent into a circle.

In our example, with a charge of 12 units per centimetre, the potential will be 237.

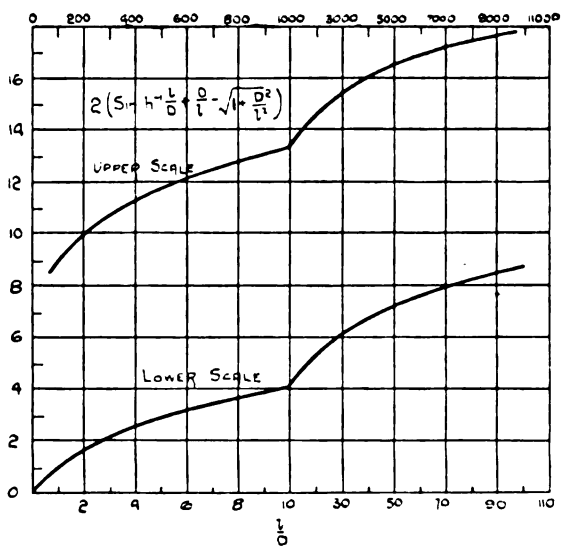

FIG. 3.

(2) The Average Potential of the Horizontal Suspension Wire Due to the Antenna Wires.

From Fig. 24 in the original Paper it is found that the potential at F, due to the diametrically opposite wire OP of the cone, is 1·0, at E 1·05, at D 1·2, at C 1·7; thus the average over EF is 1·025, over DE 1·12, CD 1·4, while from Fig. 23, the average over $PC=2{\cdot}6$. Hence

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the average potential over the whole circle due to the charge on one antenna wire = 1·54, and that due to the whole 160 wires, 246.

Hence the potential of the suspension wire

due to its own charge	=	237
,, antenna wires	=	246
,, its own image	=	− 20
,, image of 160 wires	=	−106
Total	=	357

The potential previously calculated for the 160 antenna wires will be modified by the presence of the charge on the suspension wire.

We will here make use of an important theorem: The average potential over a surface of area A, due to a charge uniformly distributed over another surface of area B, is equal to the average potential over the second surface due to the same charge uniformly distributed over the first surface. If the charges are not equal in the two cases, the potentials vary in direct proportion to the charge. To prove this theorem let l be the distance between two elements δA and δB of the surfaces; then if the area B have a uniform density σ_b, the potential of the element δA will be $\sigma_b \int \frac{dB}{l}$, and the average potential over the whole of the surface A will be obtained by integrating over the surface and dividing by its area thus

$$(\sigma_b/A) \int\int \frac{dBdA}{l} = \frac{Q_b}{AB} \int\int \frac{dBdA}{l}$$

where Q_b is the total charge on the area B. Similarly the average potential of B, due to the charge on $A = \sigma_a/B \int\int \frac{dAdB}{l} = \frac{Q_a}{AB} \int\int \frac{dAdB}{l}$.

If $Q_a = Q_b$, the average potentials are equal.

Now since we have calculated the average potential of the circular cable, due to one wire of the cone, we can write down at once the potential of the latter due to the charge on the former. It is

$$1{\cdot}54 \times \frac{320 \times 12}{100} = 59.$$

The average potential of any wire of the cone which was previously calculated to be 381, will therefore be increased to 381 + 59 by the presence of the charged suspension cable; the earth image of the latter will, however, reduce this by 25, giving a resultant of 415.

On the cone we have 16,000 × 30·5 units at a potential of 415, and on the suspension cable 3,840 × 30·5 units at a potential of 357, giving a total charge of 19,840 × 30·5 units at an average potential of 404.

$$\text{The capacity} = \frac{19{,}840 \times 30{\cdot}5}{404} = 1{,}500 \text{ cm.}$$
$$= 1{,}670 \times 10^{-6} \text{ mfd.}$$

This is an increase of 17 per cent. due to the suspension cable, but the actual increase will be greater, since, the calculated potential of the cable being less than that of the wires of the cone, it is evident that the density on the cable is greater than has been assumed. All faulty assumptions as to the distribution of the charge

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give values below the true capacity. A recalculation shows that to give the same potential in all the wires, the charge on the cable should be 16 units per centimetre of length, and not 12, as has been assumed ; this increases the capacity to $1,680 \times 10^{-6}$ mfd., which is 18 per cent. greater than that calculated without the suspension cable.

Again, another example consists of " four vertical parallel wires 110 ft. long and 0·1 in. diameter, spaced 6 ft. apart at the angles of a square = 583 micro-micro-farads." This type of antenna was considered in the original Paper (*see* Fig. 18), and since $l/D = 18{\cdot}3$ and $d/r = 1,440$, the capacity will be about 3·85 per foot, or 424×10^{-6} mfd. in total. This neglects the effect of the earth, which is determined as follows : The potential of the antenna

due to its own charge	=	35·2
,, its earth image	=	− 4·0 approx.
The resultant potential	=	31·2

Hence the capacity will be increased in the ratio of 35·2 to 31·2—*i.e.*, 13 per cent.—which gives a total capacity of 478 micro-microfarads, which is only 82 per cent. of the measured value. That these discrepancies are due to such disturbing factors as masts and buildings, particulars of which are not given, is proved by the fact that the calculated and measured values agree very well even in the case of very complex arrangements of wires, if the disturbing factors are carefully eliminated or calculated and allowed for.

The Effect of Masts.

The method of calculating the effect of masts and buildings will now be considered, commencing with the simple case shown in Fig. 2, where a single vertical wire runs parallel to a cylindrical mast.

Let l = the length of mast or wire, r = radius of wire, r_m = radius of mast, D = distance between wire and mast.

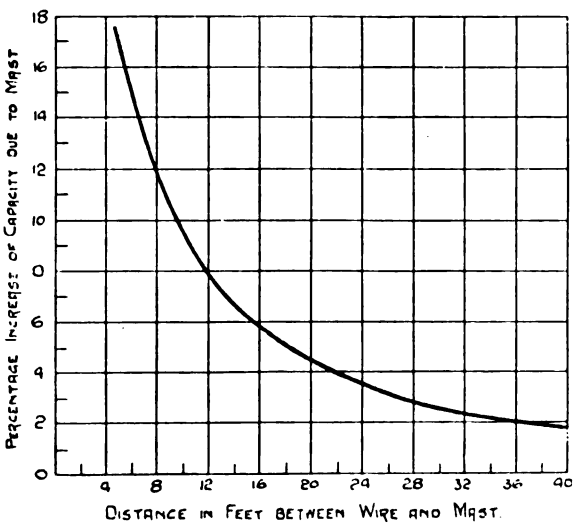

FIG. 4.

If the wire be assumed to have a uniform charge of 1 unit per centimetre of length, it will induce on the mast a negative charge of a units per centimetre, which we assume to be also uniformly distributed. Their images in the earth will be equally and oppositely charged. The value of q can be determined from the fact that the resultant potential of the mast must be zero, since it is connected to the earth. Having determined q, the potential of the insulated wire can be found and thus

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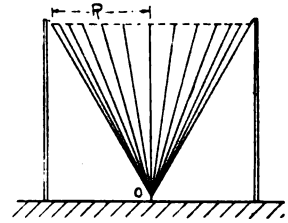
also its capacity. In most cases the value of l/D will not be large enough to enable the approximate logarithmic formula to be used, and it will be necessary to employ the accurate formula for the potential of one conductor due to the charge on a parallel conductor—viz. (*The Electrician*, Vol. LXXIII., p. 859):

$$V_{av.} = 2\left(\sinh^{-1}\frac{l}{D} + \frac{D}{l} - \sqrt{1+\frac{D^2}{l^2}}\right).$$

On substituting r for D this formula can also be employed to find the potential due to the charge on the conductor itself, even if the ratio of its length to its radius is not exceedingly great. The values of this expression for different values of l/D are given in the following table and are plotted in Fig. 3.



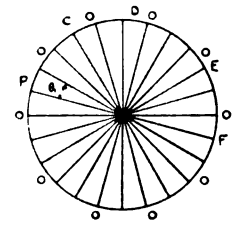


FIG. 5.

l/D.	$V_{av.}$	l/D.	$V_{av.}$	l/D.	V_{av}	l/D.	$V_{av.}$
1	0·936	15	4·93	100	8·62	1,300	13·72
2	1·648	20	5·48	200	9·98	2,000	14·58
3	2·196	30	6·27	350	11·1	4,000	15·97
5	2·986	40	6·81	500	11·81	8,000	17·18
7	3·554	50	7·26	750	12·62	—	—
10	4·186	75	8·05	1,000	13·20	—	—

In our example (Fig. 2), let $l=200$ ft., $r=0{\cdot}05$ in., $r_m=6$ in., $D=10$ ft.; so that $l/r=48{,}000$; $l/r_m=400$ and $l/D=20$.

The potential of the mast

due to its own charge	$=-11{\cdot}34\,q$.
,, its own image	$=+\ 1{\cdot}38\,q$
,, the charge on wire	$=+\ 5{\cdot}48$
,, the image of wire	$=-\ 1{\cdot}33$

Of these four component potentials, the first and third are read off the curves in Fig. 3, the second was determined on page 907 of the original Paper, while the fourth is found from the following considerations. If the wire and mast were both twice as long—that is, as long as themselves plus their images—l/D would be increased to 40 and $V_{av.}$ to 6·81. This would be the average potential of the whole, or of either half of the 400 ft. mast due to the 400 ft. wire; hence it is the potential of the actual 200 ft. mast due to the 400 ft. wire. Now the potential of the actual mast due to the actual 200 ft. wire is only 5·48, and the difference—viz., 1·33—must he due to the charge on the image of the wire.

Seeing that the mast is earthed, its resultant potential must be zero, and therefore

$$5{\cdot}48-1{\cdot}33-(11{\cdot}34-1{\cdot}38)q=0,$$

or $q=0{\cdot}417$ units per centimetre of length. Hence the potential of the wire

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Due to its own charge	=	20·9 (*see* Fig. 3 in original Paper)
,, its own image	= —	1·0 (*see* Fig. 21 *et seq.*)
,, charge on mast	= —	2·28 (=0·417 × 5·48)
,, image of mast	=	0·56 (=0·417 × 1·33)
Resultant potential of wire	=	18·2

Hence the presence of the mast lowers the potential of the wire from 19·9 to 18·2, thereby increasing its capacity 9·3 per cent. The effect of altering the distance between the wire and the mast is shown in Fig. 4.

(To be continued.)

Pocket Wireless Outfits

AMONG the lesser horrors attributed to the great war must be included the publicity given to pseudo-inventors whose products may be imagined to have possible military application. Doubtless many of the devices worked out by these untrained inventors are in some degree applicable to the services for which they were intended. News of the few which possess startling merit ultimately reaches the ears of the various imperial commissions or other bodies which have the power and the desire to investigate and utilise the inventions. But the wheat of valuable plans is so nearly smothered by numbers of chafflike schemes that the true worth of the better ideas is likely to be overlooked. This is all the more probable because astounding claims, even though untrue, tend to overshadow conservative statements of demonstrated facts.

In the past few years a dozen or two " inventors " have put together compact receivers for wireless telegraphy, shown that by their use they could receive messages from powerful stations at moderate distances, and then announced loudly that they had produced " new " wireless systems which completely eliminated tall aerial structures, bulky instruments, and what not ! The absurdity of such contentions as based upon any such performance is only too evident to the technical man ; to the lay mind, however, there appears always to be something particularly appealing in the alleged solution of a great problem by an inventor who has attended only the " school of experience." It seems unnecessary that the curriculum there pursued by him should have been either effective or extensive !

Truly, the sensitive and selective wireless receiver which is small and light enough to be easily portable has many uses, not the least important of which are on the field of battle. Similarly, reception of messages from considerable distances by the use of ground wires, and without tall aerial masts, is often advantageous. Both of these possibilities are made use of in practical radio-telegraphy, and have been utilised for many years. The production of vigorous radiated waves from low antenna wires, and the design of powerful transmitting apparatus of so little bulk and weight that it is not hard to transport, however, are vastly different problems. The difficulties of producing the ideal aeroplane motor are combined with those of leading large currents through slight conductors, and of restraining high voltages with flimsy insulation. Our earnest reporters of the daily press would do well to scrutinise the claims of new inventors without losing sight of the conservation of energy.

(Electrical World.)

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A Personal Page

Photos by] [*Val L'Estrange, Alfieri, and P. W. Harris.*

Top left.—SENATORE MARCONI'S BEAUTIFUL CHILDREN, MASTER GIULIO AND MISS DEGNA MARCONI.

Top right.—SENATORE MARCONI'S CHILDREN RIDING IN ROTTEN ROW, WITH THEIR "ARMLETTED" TUTOR.

Bottom.—EAGLEHURST, NEAR SOUTHAMPTON, FOR MANY YEARS SENATORE MARCONI'S HAMPSHIRE RESIDENCE.

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Among the Operators

Sad Death from Pneumonia.

We regret to announce the death from pneumonia of a member of the Marconi Company's Marine Operating Staff, Mr. Duncan Roy MacDermid. Mr. MacDermid, who was but eighteen years of age and one of the most recent recruits to the wireless service, was born in Dumbarton and spent most of his life in Glasgow. Upon leaving school he entered the service of the Glasgow newspapers *The Bulletin* and *The Evening Times*, where he was engaged in the process and engraving department. Taking an interest in wireless telegraphy, he undertook a course of training at the Royal Technical College, Glasgow, and entered the Marconi Company's School in June of this year. After a short finishing course he was appointed to the Cunard liner *Andania* as assistant operator, and had been but a few days at sea when he was taken ill. On arrival at New York Mr. MacDermid's condition was so serious that he had to be immediately removed to a hospital ashore, and passed away shortly after his admission to that institution. We offer our sincerest sympathy to the late Mr. MacDermid's parents in their sad bereavement. The loss is a particularly sad one as Mr. MacDermid's elder brother, Sec. Lieutenant Donald Russell MacDermid, H.L.I., was killed in action at the end of June.

* * * * * *

A Gallant Officer.

We further regret to announce the death, on the field of honour, of Sec. Lieut. Hubert Patrick Fisher, of the Shropshire Light Infantry. Lieutenant Fisher left the service of the Marconi Company in the spring of 1915, and obtained his commission shortly afterwards. Lieutenant Fisher was drafted into the Gloucesters owing to the shortage of officers. Whilst leading a platoon of the latter regiment into the front trenches he met his death, and his body lies buried in a little cemetery in the vicinity. It was in October, 1914, that the late officer, who was but twenty years of age and hailed from the town of Galway, joined the Marconi Company, and shortly after taking up his duties was appointed to some special war work. Later on he was given charge of the wireless on the s.s. *Pembrokeshire*, upon which vessel he was serving when he left. The deepest sympathy of all who knew this gallant young man will be extended to his mother and father in their terrible loss.

THE LATE OPERATOR MACDERMID.

* * * * *

An Admiralty Award.

Hearty congratulations to Operator John McMillan, who has just received from the Admiralty a gold watch in recognition of

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OPERATOR J. MCMILLAN.

his services on the torpedoed s.s. *Wayfarer*. Our readers will remember that in our May issue of last year we dealt with this case and pointed out the important part played by wireless telegraphy in the incident. Mr. McMillan is twenty-four years of age, and has served in the Marconi Company since June, 1913, when he entered the London School from the Post Office. His first ship was the s.s. *Andania*, and from this he transferred to the s.s. *Haverford*, afterwards serving on s.s. *Hesperides* and s.s. *Scandinavian* before being appointed to the s.s. *Wayfarer* in March, 1915. Escaping from the disaster which overtook that ship, he next joined the s.s. *Whakarua*. In addition to the watch from the Admiralty, Mr. McMillan has received a gift of money from Messrs. T. & J. Harrison, owners of the *Wayfarer*.

* * * * * *

S.S. "MASCOTTE."

This ship, which was mined in September, carried as its operator Mr. John Strang. Mr. Strang, who is a Scotsman and nineteen years of age, joined the Marconi Company in July, 1915, having received his P.M.G.'s first-class certificate at the North British Wireless Schools, Glasgow. After making his first voyage on the s.s. *Cameronia*, he was appointed to the s.s. *Cassandra*, on which ship he remained for a considerable time. He was appointed to the s.s. *Mascotte* at the beginning of August, a month before the ill-fated vessel met with her accident.

OPERATOR JOHN STRANG.

Wireless Telegraphy on Aeroplanes

ACCORDING to American reports, what is claimed to be a record in wireless telegraphy from aeroplanes was recently established by Captain Culver, of the U.S. Army Aviation Corps. During a flight from San Diego to Santa Monica, 114 miles away, he is stated to have kept in touch with his station by sending wireless messages every three minutes. The power for the transmission set is derived from a generator placed on the lower wing section of the aeroplane, and driven by a two-bladed propeller. Aerial wires are suspended from the "fuselage" of the machine, with an insulated counterpoise hung from the wings to the tail of the aeroplane. The complete transmission set is stated to weigh less than 40 lb.

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American Letter

New York, August 28th, 1916.

THE closing of the summer season marks the resumption of the activities of the Institute of Radio Engineers, and its first meeting after the summer vacation is to be held on Wednesday evening, September 6th, at 8.15 p.m., Room 2 of the Engineering Societies Building, 33 West 39th Street, New York City.

There will be presented two brief papers by Mr. Leonard F. Fuller on "A Brief Technical Description of the New San Diego Pearl Harbour, and Cavite High Power Naval Radio Stations" and "A Few Experiments with Ground Antennas." In addition, there will be presented a paper by Prof. Charles A. Culver on "Notes on Radiation from Horizontal Antennas."

Much interesting and practically important material is included in these papers.

As you will recall, the Institute meetings were previously held at Fayerweather Hall, Columbia University, but owing to the central location of the Engineering Societies Building and the increased interest shown by electrical engineers in the radio art it has been arranged to hold meetings hereafter at the Engineering Societies Building, where greater facilities are obtained.

Among the most important activities of the Institute may be mentioned the work of the Committee on Wave Length Regulation, which has been appointed to carefully study the existing conditions and to suggest such improvements as are deemed advisable. This, as you will understand, is a considerable task when it is remembered that recommendations, to be of practical value, must embrace conditions which exist internationally as well as in the United States. It is also necessary to take into account the fact that thousands of ship and shore stations already equipped with radio apparatus and which have accommodated themselves to operate in accordance with existing rules and regulations, will be affected by new regulations. The work of this Committee and its recommendations will probably be submitted at the next international radio telegraph convention. The members of this Committee consist of the following:

John Stone Stone (Chairman).

E. F. W. Alexanderson.
Edwin H. Armstrong.
Louis W. Austin.
H. Boehme.
William H. G. Bullard.
George S. Davis.
Lee deForest.
Melville Eastham.
Lloyd Espenschied.
Leonard Fuller.
Alfred N. Goldsmith.
John L. Hogan, Jun.
Frederick A. Kolster.
Ralph H. Langley.
Fritz Lowenstein.
Emil E. Mayer.
Greenleaf W. Pickard.
Samuel Reber.
David Sarnoff.
Frederick Simpson.
T. Lincoln Townsend.
Roy A. Weagant.
Arthur G. Webster.
Leonard D. Wildman.

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In the field of long distance communication, interest in the United States is now centred on the tests being conducted between the Marconi Stations at San Francisco, Calif., and Honolulu, Hawaiian Islands, and the Japanese Government station at Funabashi. The tests so far have been successful and the establishment of a commercial service between the United States and Japan by the Hawaiian station is expected shortly.

The American Marconi Company is now offering to license manufacturers and others selling radio apparatus for experimental purposes, under its tuning patent, on a royalty basis. Contracts have been closed by the Marconi Company with the Clapp-Eastham Company, a well-known amateur apparatus concern of Boston, Mass., the William J. Murdock Company of Chelsea, Mass., and also with the Sears-Roebuck Company, of Chicago, Ill. The last mentioned concern is the largest mail order house in the world. The Sears-Roebuck Company have established a wireless department, issuing a catalogue of amateur radio apparatus now licensed under Marconi patents.

As indicating the interest shown by electrical journals in the development and operation of radio apparatus, I might quote from *The Electrical World* issue of August 12th, 1916, where it devotes editorial space to a unique case, the circumstances of which are as follows:

The operator in charge of a wireless station installed on a vessel left his cabin for a few minutes, during which time an unscrupulous person entered the radio cabin and purloined the crystal detector from the tuner, as well as the spare crystal detectors which were lying in a box on the operating table. The ingenuity of this particular operator was not all that could be desired, and as a result the vessel was unable to receive wireless signals for a period of two and a half days. Says *The Electrical World:*

"EMERGENCY RADIO SERVICE ON SHIPBOARD.

"A few weeks ago the Department of Commerce which controls the federal "inspection of wireless telegraph stations, issued a circular letter calling attention to "the need of providing spare parts for use in case of breakdown. An instance was "cited in which a coastwise vessel was forced to go two and a half days without "radio service because of the lack of a detector crystal for replacement. The letter "from the Department of Commerce points out further that the operator was unable "to improvise a detector from the materials at hand.

"A condition in which the operation of a wireless telegraph outfit must be "entirely suspended on account of the lack of a spare bit of carborundum is not "healthy. That it can exist reflects no credit upon either the operator himself, the "company which trained and employed him, or the naval examiners who granted his "licence certificate. This is quite over and above that part of the responsibility of "the operator to construct a temporary detector of at least enough sensitiveness and "reliability to keep the ship radio in operation.

"It is a notable fact that the operating personnel of our merchant ships, or at "least a large part of it, is constantly changing. New operators are being licensed "daily; they are trained to understand the workings of modern radio apparatus,

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" but have as a rule practically no knowledge of the older instruments which have " been displaced. Their training, furthermore, is usually of the kind directed " toward obvious and mechanical results of various manipulations, rather than toward " the true functional performance of the several instruments in their charge. All " this is unfortunate, for it leads to just such failures in emergency as that outlined by " the Department of Commerce.

" Had the operator, who was forced to sit idly by his dead receiver because the " crystal had been stolen, known a little of what expedients were made use of in the " early years of wireless telegraphy there would have been no failure to protect his " ship by radio service. Two needles and a pencil, a knife-blade and a broken " incandescent lamp, a piece of dry-cell carbon and an iron wire—any of these could " be used as a microphonic detector which would take the place of the crystal and " receive signals from fifty to one hundred miles. Surely these simple materials were " available to the stranded operator, and certainly the receiving range to be obtained " by their use, even though limited, was worth striving for. The student of the " literature of wireless telegraphy would never be at a loss for a simple but useful " detector ; the man who recognises not only effects but also the reasons for them is " needed as much in the practice of radio-telegraphy as in other fields of applied " science. Wireless operators on ships should have better training ; their instruction " should be carried on beyond the point which permits them barely to secure a ' Government licence to hold a position."

The Electrical World, in its editorial comment, apparently overlooks the fact that spare crystals were provided in this case, but that the intruder was entirely without a conscience.

DAVID SARNOFF.

This is the Life

BY OUR IRRESPONSIBLE EXPERT.

A YOUTH who has a P.M.G. most usually proceeds to sea, and thereupon at first thinks he, the life is simply grand. But when a day or two has passed, and England's shores are fading fast, he looks across the ocean vast and wishes for the Strand. It isn't that he feels unwell—oh, no, he's sound as any bell—but something that he's eaten : well, it wasn't quite the thing. So from the cabin watch him go, he says to change his tie, you know, and while the stormy winds do blow, he tries in vain to sing. Until the dreaded Bay is crossed he thinks his little life is lost, as while the ship is tempest tossed he doesn't care to eat. But in a day or two the sea has settled down quite normally, and now as brave as brave can be he welcomes tropic heat. The dimly-veiled Canary Isles, across the water many miles, appear like nature wreathed in smiles as to the rail he hies. And all the girls on deck delight to see him strutting morn and night in uniform a dazzling white—a sight for weary eyes. His seediness has passed away, he welcomes now each coming day—this is the life ! he says, hooray ! This is the job for me ! No nasty working in a store, no racing for the seven four, no ! Nothing nasty any more. I'm absolutely free !

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An American Transmitter and Receiver

THE photographs on this and the next page show a wireless receiver and transmitter recently produced in the United States and placed on the market for the benefit of wealthy amateurs who prefer to buy their installations ready made and in compact form. The detectors shown in Fig. 1 are of the three-electrode vacuum-valve type, and one or other of them can be switched into circuit at will. The receiver is inductively coupled, and contains in the aerial circuit a variable inductance, condenser, and a coupling coil. In the secondary circuit we find an inductance shunted by a variable condenser, the detector being connected to this oscillating circuit in the usual way. The handle controlling the variable primary condenser, which is of the semi-circular plate type, will be seen at the top left-hand side of the case, the secondary condenser occupying a similar position on the right-hand side. Beneath the primary condenser will be seen a three-finger switch by which the condenser can be placed either in series or in shunt with the aerial tuning inductance. This last is varied by the double switch immediately below the left-hand detector, one set of studs being connected to unit turns and the other to larger sections of the coil. In this way any number of turns can be brought into circuit at will. The two small two-way switches on the left of the inductance are arranged to cut out sections not required, so as to avoid what is known as the "dead-end" effect. Beneath these switches will be seen the aerial and earth terminals. The voltmeter between the two detectors can be used to test the voltage across the filament, between the filament and the grid, or between the filament and the plate, by means of the two-finger switch beneath the secondary condenser, whilst the resistance in series with the filament itself is controlled by the switch beneath the voltmeter. The coupling is varied by sliding backwards or forwards the handle seen protruding from the slot on the right hand of the instrument, the handle itself forming a switch which can be used for varying the secondary inductance. Four terminals are seen at the bottom right-hand corner of the case, the telephones being connected to the outer of these two and the battery to the inner two. A safety gap for protecting the apparatus from high voltage is provided in the centre of the front panel immediately beneath the central switch. The only switches remaining to be mentioned are, that on the extreme right beneath the secondary condenser, for adjustment of the filaments, and that on the extreme left beneath the primary condenser, called the "telephone regulator."

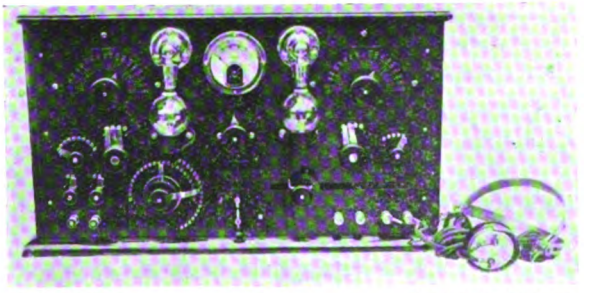

Photo by [*Frank C. Perkins.*

FIG. 1.

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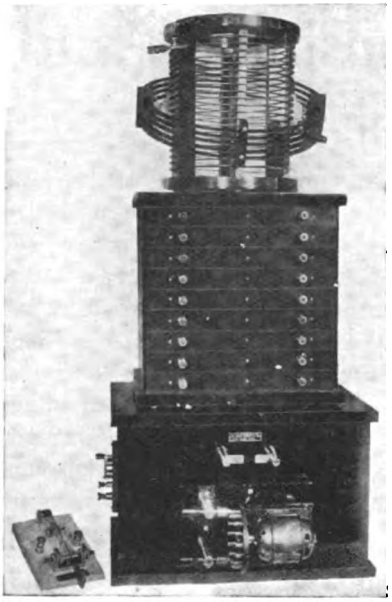

Photo by] [Frank C. Perkins.

FIG. 2.

The transmitting apparatus calls for little remark (see Fig. 2). The transformer is contained in the lower case, and various windings can be brought into circuit by means of the switch seen on the left. The condenser, in sections, will be seen in the top case, on which stands the oscillation transformer. This consists of a primary of five turns of flat copper strip, the amount of inductance included in the circuit being controlled by the clip shown. The secondary contains a much larger number of turns, also of copper strip, any amount of which can be included in the aerial circuit by varying the upper clip. The primary is pivoted in such a way that coupling can be loosened by rotating it through an arc of a circle. The discharger, which is of the rotary type driven by a small electric motor, needs no explanation, the photograph showing its details admirably. Finally, we would call attention to the transmitting key shown on the left of the photograph and mounted on a marble base. A novel point about this key is that it is operated *sideways*, and not up and down as is usual.

Radio-Telegraphy and American Preparedness

UNDER the above heading an American contemporary, remarks:

"The importance of radio communication in war is so great that any attempts "to support the proposition by argument would be supererogatory. Moreover, the "nation which shall have brought the development of radio-telegraphy to the "highest pitch before the outbreak of war will, other things being equal, possess a "great advantage over its enemies, in so far as relates to long-distance communica-"tion with and between its fleets at sea.

"Obviously, therefore, the best methods of being prepared against hostilities "in the field of radio communication is to have plans prepared for the prompt "occupation and utilisation of all coast radio stations at the first outbreak. There "should, on the declaration of martial law, be complete and speedy mobilisation "of all radio activities by the military and naval forces. But, on the other hand, "there should be the minimum of interference by the government with commercial "radio communication during times of peace. Radio communication is still a very "young art. It hardly goes back to the beginning of this century. Much capital "has been honestly invested in it. There is an enormous field for the development "of the range, precision, cheapening, and improvement of radio signalling. The

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" best way to encourage that development is to give fair play, and free play, to all " inventors, business men and industrial forces, whereby, for gain and commercial " advantage, it may be possible to enlist the interest and industry of the greatest " number of workers in this field. On the other hand, the surest way to discourage " the art, science and engineering of radio communication is to convert the whole " field, during peace times, into a monopoly of some department of the government, " civil or military. To place all radio signalling in the hands of, say, the navy " department, during times of peace, would be to hamper all progress and hinder " all development, thus tending to keep America in the background of radio communi- " cation, for any purpose peaceful or warlike. This is, of course, no reflection on " naval officers or the navy, who in their own field are the pick of the nation and " worthy of all our support. It goes without saying, however, that such officers " are necessarily too busy with their immediate routine duties to spend much time " and money in invention and development in radio engineering. Any monopoly " of a great business inevitably leads to lack of competition, to lack of stimulus " and to stagnation. Progress comes from holding open the avenues of success to " individual talents, industry, and enterprise. Let us hope that the progress and " wealth of the nation, in so important and all-pervading a field as radio communica- " tion, in time of peace may be fostered by keeping it out of the deadening clutch " of government monopoly."

Wireless at Chatham Islands

ANENT our remarks on the Chatham Islands in a previous issue an article appears in our New Zealand contemporary, *The Katipo*, from which we extract the following, which we think may interest our readers :—" Owing to the fact that " steamer service to Chatham Islands is somewhat erratic, residents find it necessary " to keep a close watch on the ' larder,' but, in spite of such precautions, something " is usually omitted from the mail order, and consequently the wireless service is " utilised as the only resort : it being better to spend a few shillings on ' radio ' to " ensure that goods will arrive by next steamer than to wait many weeks.

" Though the station has been open for traffic only since September, 1913, " there has never been an occasion on which communication has not been effected " with Radio—Wellington. On many occasions the station has done good work, the " most recent case happening on March 23rd last, when the operator on duty at " Chathams was the first to distinguish the calls of the *Aurora* (Shackleton Expedi- " tion), which was calling New Zealand stations with urgent traffic. There was a " great deal of interference due to statics and ' jamming ' at the time and the call " was apparently not distinguished at the New Zealand stations immediately. " Radios, Wellington and Awarua, being informed by Chathams that the *Aurora* " was calling, the Awarua station immediately engaged that vessel and succeeded " in working her successfully, though her signals at the time were very weak and the " interference considerable."

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Foreign and Colonial Notes

Canada.

We see from *The Electrical World* that Mr. Philip E. Edelman, of St. Paul, Minn., has been engaged by the Canadian Government as electrical engineer to plan a system of radio-communication to protect and secure communication in the vast Dominion parks in Western Canada. A chain of wireless stations of new design will be installed to prevent forest fires and poaching, and for general park work in the Canadian Rockies, covering a territory 7,000 square miles in extent. Mr. Edelman is an engineering graduate of the University of Minnesota, and has installed a number of large radio plants. He is also the author of *Experimental Wireless Stations, Experiments,* and *Inventions and Patents.*

* * * * * *

New Zealand.

According to the Annual Report of the Post and Telegraph Department for the year 1915, wireless communication on long waves between Awanui and Apia, Samoa, a distance of 1,550 nautical miles, established shortly after the capture of the Samoan group by the New Zealand Expeditionary Force, on behalf of the Imperial Government, on the outbreak of war, continues to be satisfactorily maintained.

* * * * * *

The wireless station at Awarua recently served a useful purpose that is unusual in these waters. The chronometers of the *Aurora* had not been checked since that vessel's departure for the southern seas. The vessel was returning damaged, and required correct time to check the chronometers. Arrangements were made by which, at the three consecutive hours of 11 a.m., noon, and 1 p.m., the Observatory clock at Wellington was connected direct to a land-line circuit to the Awarua wireless station. The length of this circuit was approximately 650 miles. The ship was on the look-out for a wireless signal, which was despatched by preconcerted arrangement practically simultaneously with its receipt over the land circuit. The result was found to be highly satisfactory.

* * * * * *

United States.

The adoption of wireless telegraphy by societies and other corporate bodies is becoming more and more marked as time goes on. An agitation is afoot by members of the Iowa National Guard to obtain a wireless installation. They are ready to organise a wireless corps aerial division if the Government will permit it. So far their efforts have been fruitless, but in course of time, no doubt, their wish will be gratified and a wireless station established similar to that at Omaha.

* * * * * *

As briefly reported in our last issue, the National Amateur Wireless Association is in camp at Birchwood Lake, Monticello, N.Y. Through the kindness of the American Marconi Company a complete 2 kw. Marconi set has been lent to the Association for use in camp.

* * * * * *

What is said to be the only wireless plant in existence operated to keep a moving

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picture company in communication with the mainland is that of the Santa Cruz Islands in the Pacific Ocean, where a company is filming a new play. Arrangements were made for a daily wireless service during the stay of the company on the Islands. No other means of communication exist except a launch which makes the 40-mile trip to the mainland once a week.

* * * * * *

At the request of the Weather Bureau, arrangements have been made by the United States Bureau of Lighthouses for taking weather observations on the light vessels at Nantucket Shoals, Mass.; Diamond Shoals, N.C.; Frying-Pan Shoals, N.C., and Heald Bank, Texas. These light vessels are all equipped with wireless apparatus by means of which observations may be transmitted to any point desired.

* * * * * *

The wireless station at Fort Riley, Kansas, has been closed until further notice. This, we understand, is on account of the small force stationed at that point. The station will be reopened for operation when the troops are returned for permanent occupation.

* * * * * *

What is hoped will become an annual custom was inaugurated recently in New York. The American Marconi Company placed a wreath on the monument erected in Battery Park in that city to the wireless operators who have given up their lives to the call of duty. The monument itself was dedicated on May 12th, 1915, with impressive ceremonies, of which a full description was given in our July, 1915, number.

* * * * * *

The United States Naval Observatory states that the difference in the time signal between the Isthmus of Panama and the Arlington station is about ·02 second, and a lag of 0·27 second between the Isthmus and Key West, the latter being due to the various relays used in the commercial telegraph lines over which the signal passes from the Naval Observatory. The error in the time signal sent from the radio station is usually less than 0·1 second.

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The Marconi Wireless Telegraph Company of America will allow half pay until January 1st, 1917, to those of its employés who are members of the militia and are called upon by the Government for service, and will keep their positions open during that time. After January 1st the matter will receive further attention.

Employés of over one year's service temporarily transferred to Government service will continue to be protected under the Marconi Company's life insurance plan, and such absence from the company will not interrupt the continuity of the employés' service and seniority benefits.

The company will waive the usual fee charged students in its wireless school and will instruct them without cost until January 1st, 1917.

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Some months ago we mentioned that a new wireless station was to be erected at Port Isabel, Texas. We understand now that this installation is almost ready to be placed in commission. As far as is known at present, it will handle commercial traffic.

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Instructional Article

NEW SERIES (No. 14).

The following series, of which the article below forms the fourteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

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93. One slightly different type of simultaneous equation is that in which one equation is of the first degree and the other of a higher degree. For example,

$$3x+y=5 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(i)}$$
$$x^2-4xy+7=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(ii)}$$

In this case it will be found impossible to juggle with the two equations so that either x or y will cancel out altogether; and we therefore adopt a substitution method.

We know that $3x+y=5$, and from this we find that $y=(5-3x)$. Now substitute this value of y in the second equation—

$$x^2-4xy+7=0$$
$$\text{becomes } x^2-4x(5-3x)+7=0$$
$$\text{or } x^2-20x+12x^2+7=0$$
$$13x^2-20x+7=0.$$

Therefore, applying the formula

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a},$$

we get

$$x=\frac{-(-20)\pm\sqrt{(-20)^2-4(13)(7)}}{2\times 13}=\frac{20\pm\sqrt{400-364}}{26}$$

$$=\frac{20\pm\sqrt{36}}{26}=\frac{20\pm 6}{26}=\frac{26}{26}\text{ or }\frac{14}{26}=1\text{ or }\frac{7}{13}.$$

Putting $x=1$ in the equation $3x+y=5$, we get $3+y=5$ or $y=2$.

and putting $x=\frac{7}{13}$ we get $\left(3\times\frac{7}{13}\right)+y=5$ or $y=5-\frac{21}{13}=5-1\frac{8}{13}=3\frac{5}{13}$.

Thus we get the solution—

$$x=\begin{cases}1\\ \text{or}\\ 1\frac{7}{13}\end{cases}\qquad y=\begin{cases}2\\ \text{or}.\\ 3\frac{5}{13}\end{cases}\qquad \textit{Ans.}$$

Examples for Practice.

Solve the following simultaneous equations—

13. $\begin{cases}6x-2y=2\\ x^2-xy+y^2=1.\end{cases}$ 14. $\begin{cases}2y-17=3x\\ 2x^2+xy=6.\end{cases}$ 15. $\begin{cases}4x+1=-6y\\ x^2+xy=28.\end{cases}$

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94. We have now dealt with the following cases of the solution of equations :

(1) One equation and one unknown ;

(2) Two equations and two unknowns ;

(3) Three equations and three unknowns.

We will now deal with

(4) Two equations and three unknowns.

The best we can do in this case is to find the *ratios* of the three unknowns.

We can do this if we have two equations of the following general form :

$$a_1x+b_1y+c_1z=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$
$$a_2x+b_2y+c_2z=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Here x, y and z are, as usual, the unknowns, and a, b and c are constants.

First of all divide by z all along both equations.

Then $$a_1\left(\frac{x}{z}\right)+b_1\left(\frac{y}{z}\right)+c_1=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and $$a_2\left(\frac{x}{z}\right)+b_2\left(\frac{y}{z}\right)+c_2=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

We must now consider $\left(\frac{x}{z}\right)$ and $\left(\frac{y}{z}\right)$ as two new unknowns, and set to work to evaluate them.

As in our previous work, we juggle with one of the equations so as to enable us to cancel out one of the unknowns when adding or subtracting the two equations.

Let us alter equation (4) so that we can cancel out $\left(\frac{x}{z}\right)$. To do this we must multiply all along by $\left(\frac{a_1}{a_2}\right)$.

$$\left(\frac{a_1}{a_2}\right)\times a_2\left(\frac{x}{z}\right)+\left(\frac{a_1}{a_2}\right)\times b_2\left(\frac{y}{z}\right)+\left(\frac{a_1}{a_2}\right)\times c_2=\left(\frac{a_1}{a_2}\right)\times 0$$

$$a_1\left(\frac{x}{z}\right)+\left(\frac{a_1b_2}{a_2}\right)\left(\frac{y}{z}\right)+\left(\frac{c_2a_1}{a_2}\right)=0$$

But $$a_1\left(\frac{x}{z}\right)+b_1\left(\frac{y}{z}\right)+c_1=0. \quad \text{[Equation (3)]}.$$

Subtracting, $a_1\left(\frac{x}{z}\right)$ will cancel out, and we have left

$$\left\{\left(\frac{a_1b_2}{a_2}\right)\left(\frac{y}{z}\right)-b_1\left(\frac{y}{z}\right)\right\}+\left\{\left(\frac{c_2a_1}{a_2}\right)-c_1\right\}=0$$

or $$\left(\frac{a_1b_2}{a_2}-b_1\right)\left(\frac{y}{z}\right)+\left(\frac{c_2a_1}{a_2}-c_1\right)=0$$

Therefore $$\left(\frac{a_1b_2-a_2b_1}{a_2}\right)\left(\frac{y}{z}\right)=-\left(\frac{c_2a_1-c_1a_2}{a_2}\right)=\left(\frac{c_1a_2-c_2a_1}{a_2}\right)$$

and $$\left(\frac{y}{z}\right)=\left(\frac{c_1a_2-c_2a_1}{a_2}\right)\left(\frac{a_2}{a_1b_2-a_2b_1}\right)=\frac{c_1a_2-c_2a_1}{a_1b_2-a_2b_1}$$

Similarly, by making $\left(\frac{y}{z}\right)$ cancel out, we get $\left(\frac{x}{z}\right)=\frac{b_1c_2-b_2c_1}{a_1b_2-a_2b_1}$.

Notice here that the denominators are the same in both cases.

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Now suppose, for the sake of a simple example, that we had found $\frac{x}{z}=\frac{1}{4}$ and $\frac{y}{z}=\frac{3}{4}$, then we should say immediately that x, y and z were proportional to 1, 3 and 4 respectively. This could be written in various ways—

$$x:y:z::1:3:4$$
$$x:y:z=1:3:4$$

or $$\frac{x}{1}=\frac{y}{3}=\frac{z}{4}.$$

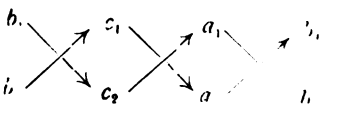
In our case, however, instead of 1 we have $(b_1c_2-b_2c_1)$
" 3 " $(c_1a_2-c_2a_1)$
and " 4 " $(a_1b_2-a_2b_1)$

Therefore we can write—

$$\frac{x}{(b_1c_2-b_2c_1)}=\frac{y}{(c_1a_2-c_2a_1)}=\frac{z}{(a_1b_2-a_2b_1)}.$$

95. *Cross Multiplication.*

A convenient short cut to the solution of this type of problem is as follows. Write down in order the two sets of coefficients of x, y and z, *starting with the coefficients of* y. Then draw arrows across diagonally between the coefficients, making them point towards the right, as shown. Next multiply across where the arrows occur, putting the products in pairs as the arrows are in pairs. Make the "downward" product positive and the "upward" product negative; thus—



$$(b_1c_2-b_2c_1)\ ;\ (c_1a_2-c_2a_1)\ ;\ (a_1b_2-a_2b_1).$$

The three quantities thus obtained are proportional to x, y and z in this order.

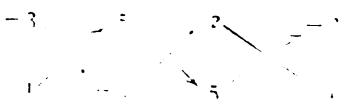
Thus $$\frac{x}{(b_1c_2-b_2c_1)}=\frac{y}{(c_1a_2-c_2a_1)}=\frac{z}{(a_1b_2-a_2b_1)}$$ as before.

Example.

Find the ratios of x, y and z from the equations—

$$2x-3y+5z=0$$
$$5x+y-3z=0$$

Set out the coefficients and arrows—



Then $$\frac{x}{(-3)\times(-3)-(1\times5)}=\frac{y}{(5\times5)-(-3)\times2}=\frac{z}{(2\times1)-5\times(-3)}$$

$$\frac{x}{9-5}=\frac{y}{25+6}=\frac{z}{2+15}$$

or $$\frac{x}{4}=\frac{y}{31}=\frac{z}{17}.$$ $x:y:z=4:31:17$. *Ans.*

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Examples for Practice.

Find the relative values of x, y and z from the following equations—

(16) $3x+2y-z=0$. $2x-y+5z=0$.

(17) $x-3y=0$. $2x+5y-z=0$.

(18) $x=2y+z$. $3y=5z-4x$.

TRIGONOMETRY.

96. It is often very convenient to be able to calculate an unknown trigonometrical ratio from a known ratio of the same angle, and when simplifying formulæ it is sometimes very helpful to express one ratio in terms of another; for example, calculate the cosine of an angle from the known value of its sine. Let the angle A of the triangle ABC (Fig. 83) be the angle θ with which we are dealing. Angle B is a right angle. We are supposed to know the value of sin θ, or $\frac{CB}{CA}$, and we want to find the value of cos θ, or $\frac{AB}{AC}$.

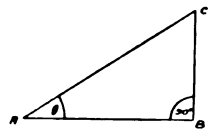

FIG. 83.

Obviously $(\cos\theta)^2$ or $\cos^2\theta=\frac{AB^2}{AC^2}$.

But as the triangle is right-angled it follows that $AB^2=AC^2-CB^2$.

Therefore
$$\cos^2\theta=\frac{AB^2}{AC^2}$$
$$=\frac{AC^2-CB^2}{AC^2}$$
$$=\frac{AC^2}{AC^2}-\frac{CB^2}{AC^2}=1-\left(\frac{CB}{AC}\right)^2$$

But $\frac{CB}{AC}=\sin\theta$, and so $\left(\frac{CB}{AC}\right)^2=\sin^2\theta$.

Therefore $\cos^2\theta=1-\sin^2\theta$.
or $\cos\theta=\sqrt{1-\sin^2\theta}$.

Another way of putting this is: $\sin^2\theta+\cos^2\theta=1$.

We can now quite easily calculate cos θ if we know the value of sin θ. For example, if sin $\theta=\frac{1}{2}$, then

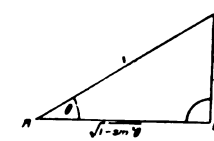

FIG. 84.

$$\cos\theta=\sqrt{1-\sin^2\theta}=\sqrt{1-(\tfrac{1}{2})^2}$$
$$=\sqrt{1-\tfrac{1}{4}}\quad=\sqrt{\tfrac{3}{4}}=\sqrt{\tfrac{3}{2}}.$$

97. A quicker, though somewhat artificial way of dealing with this matter is the following:

In the triangle ABC (Fig. 84) we *know* that the ratio $\frac{\text{side } CB}{\text{side } AC}$ is equal to sin θ. Therefore let us *call* the side CB—"sin θ," and call the side AC—"1." Then we have $\frac{CB}{AC}=\frac{\text{"sin }\theta\text{"}}{\text{"1"}}=\sin\theta$, which is correct.

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Now $AB^2 = AC^2 - CB^2$

And so $AB = \sqrt{AC^2 - CB^2}$

$= \sqrt{(1)^2 - (\sin\theta)^2} = \sqrt{1 - \sin^2\theta}$.

Thus $\cos\theta = \dfrac{AB}{AC}$

$= \dfrac{\sqrt{1-\sin^2\theta}}{1} = \sqrt{1-\sin^2\theta}$ as before.

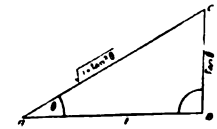

FIG. 85.

Similarly $\tan\theta = \dfrac{CB}{AB} = \dfrac{\sin\theta}{\sqrt{1-\sin^2\theta}}$, or, as $\sqrt{1-\sin^2\theta} = \cos\theta$, then $\tan\theta = \dfrac{\sin\theta}{\cos\theta}$.

In the same way as $\tan\theta = \dfrac{CB}{AB}$, we can call CB—"$\tan\theta$," and call AB—1. (Fig. 85). Then $AC^2 = AB^2 + BC^2$, and $AC = \sqrt{AB^2 + BC^2}$

$= \sqrt{1+\tan^2\theta}$.

Then $\sin\theta = \dfrac{CB}{AC} = \dfrac{\tan\theta}{\sqrt{1+\tan^2\theta}}$

$\cos\theta = \dfrac{AB}{AC} = \dfrac{1}{\sqrt{1+\tan^2\theta}}$, and so on.

One important relation is obtained by expressing $\sec\theta$ in terms of $\tan\theta$.

We have $\sec\theta = \dfrac{1}{\cos\theta} = \dfrac{1}{\frac{AB}{AC}} = \dfrac{AC}{AB} = \dfrac{\sqrt{1+\tan^2\theta}}{1}$.

Squaring we get $\sec^2\theta = 1 + \tan^2\theta$,

or $\tan^2\theta = \sec^2\theta - 1$.

We can thus express any ratio of an angle in terms of any other ratio of that angle.

Example.

Express $\operatorname{cosec}\theta$ and $\cot\theta$ in terms of $\cos\theta$.

In this case we put $AB = \cos\theta$.

and $AC = 1$ (Fig. 86), so that $\dfrac{AB}{AC} = \dfrac{\cos\theta}{1} = \cos\theta$.

Then $CB^2 = AC^2 - AB^2$

or $CB = \sqrt{AC^2 - AB^2} = \sqrt{1-\cos^2\theta}$.

Thus $\operatorname{cosec}\theta = \dfrac{1}{\sin\theta} = \dfrac{1}{\frac{CB}{AC}} = \dfrac{AC}{CB} = \dfrac{1}{\sqrt{1-\cos^2\theta}}$

and $\cot\theta = \dfrac{1}{\tan\theta} = \dfrac{1}{\frac{CB}{AB}} = \dfrac{AB}{CB} = \dfrac{\cos\theta}{\sqrt{1-\cos^2\theta}}$ or $\dfrac{\cos\theta}{\sin\theta}$.

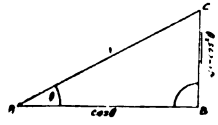

FIG. 86.

In this particular case our previous knowledge would have enabled us to arrive at these results much quicker. For

$\operatorname{cosec}\theta = \dfrac{1}{\sin\theta} = \dfrac{1}{\sqrt{1-\cos^2\theta}}$

and $\cot\theta = \dfrac{1}{\tan\theta} = \dfrac{1}{\left(\frac{\sin\theta}{\cos\theta}\right)} = \dfrac{\cos\theta}{\sin\theta} = \dfrac{\cos\theta}{\sqrt{1-\cos^2\theta}}$.

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Examples for practice,

19. (*a*) Express sin θ in terms of cot θ
(*b*) ,, tan θ ,, cos θ
(*c*) ,, sec θ ,, sin θ
(*d*) ,, cot θ ,, cosec θ.

20. If (*a*) sin θ = 0·6 ; find cos θ.
(*b*) tan θ = 4 ; ,, sec θ
(*c*) cosec θ = 10 ; ,, cot θ
(*d*) tan θ = 0·01 ; ,, cos θ and sin θ
(*e*) cos θ = − 1 ; ,, tan θ.

Solutions to Examples in Article (13).

1. $\frac{2}{x+2}+\frac{1}{x+1}$. 2. $\frac{2}{x+7}+\frac{3}{x-2}$. 3. $\frac{2}{x+2}+\frac{3}{x-2}$.

4. $\frac{5}{9(x-5)}+\frac{4}{9(x+4)}$. 5. $\frac{2x+3}{x^2-7}+\frac{1}{x+1}$. 6. $\frac{3}{(x+2)^2}+\frac{2}{x+2}+\frac{5}{x-1}$.

7. $x=5, y=2$.
8. $x=-3, y=2$.
9. $a=2, b=-7$.
10. $p=3\frac{1}{2}, q=2\frac{1}{4}$
11. $x=2, y=9$.
12. $x=11, y=2$

Wireless in the Courts

An interesting case recently came before the Magistrate's Court at Gisborne, which town is on the east coast of the north island of New Zealand, when a 16-year-old boy was charged with erecting a wireless plant without the consent of the Government. The boy's father also was charged that "between January and June, 1916, he did aid his son in committing the above offence." Evidence was called showing that the plant, if properly fitted up, could send messages a short distance and could receive from Auckland and Wellington. Counsel for the defence said the offence was admitted as far as a technical breach was concerned, and the defendants regretted the matter and gave the assurance that the apparatus was quite incapable of receiving or transmitting any message. The boy said he never sent or received any message. With the necessary crystals it might have been possible to receive from a short distance but not without them, and crystals were quite unprocurable.

The Magistrate, after hearing the evidence for the defence, said the junior defendant would be fined £2 and 7s. costs, and the father would be fined £10 and 7s. costs.

Additional Premises

We are requested to state that Messrs. Self & Son, the well-known Marconi outfit suppliers, have opened additional premises at Railway Approach, facing Fenchurch Street Station, London, E.C.

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The Wireless Station at Kamina, Togoland

WHEN, in 1914, the Allied Forces imposed upon themselves the task of defeating their German enemy in Africa, not everyone thought it would take so long. With their peculiar tenacity of purpose, which the Allies have learnt by bitter experience, the common foe is still holding out in one portion of the "Dark Continent." Togoland, however, was lost to them quite early in the campaign. On August 24th, 1914, under pressure from the advancing Allied Forces, the Germans blew up the giant wireless station at Kamina, to prevent its falling into the hands of the British. Like most German wireless stations, it was built by the Telefunken Company, of Berlin. It possessed that well-known feature by which Telefunken stations are identified—the tall triangular steel mast. Our two illustrations will give a very fair idea of the destruction wrought to the station by its former owners. The top picture shows the remains of the Power House after the explosion, whilst the lower one depicts the tangled and twisted remnants of one of the steel masts lying prone upon the ground. This ignominious position of the German mast would seem to be prophetic of that which awaits the Prussian junkers in Berlin.

REMAINS OF POWER HOUSE, KAMINA.

Photos by [*Underwood.*

WRECKED WIRELESS MAST, KAMINA STATION.

Togoland is the smallest of the four erstwhile German African colonies, and its coastline forms part of the northern boundary of the Gulf of Guinea on the west coast of Africa. It has been under German protection since 1884, and so prosperous has it become that for the last ten years or so no contribution has been required from the Imperial Government. It is hoped that the country into whose care Togoland is committed, at the settlement, will succeed in developing its resources as successfully as the Germans have done hitherto.

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A Bridal Garland

We reproduce here a picture which we think will considerably interest our readers. It represents a garland of evergreens strung up on the wireless aerials of a battleship on the occasion of the wedding of one of the ship's officers. This custom has been in vogue in the "King's Navee" from time immemorial and affords one of the best evidences of comradeship—the most cherished heritage of the British Navy.

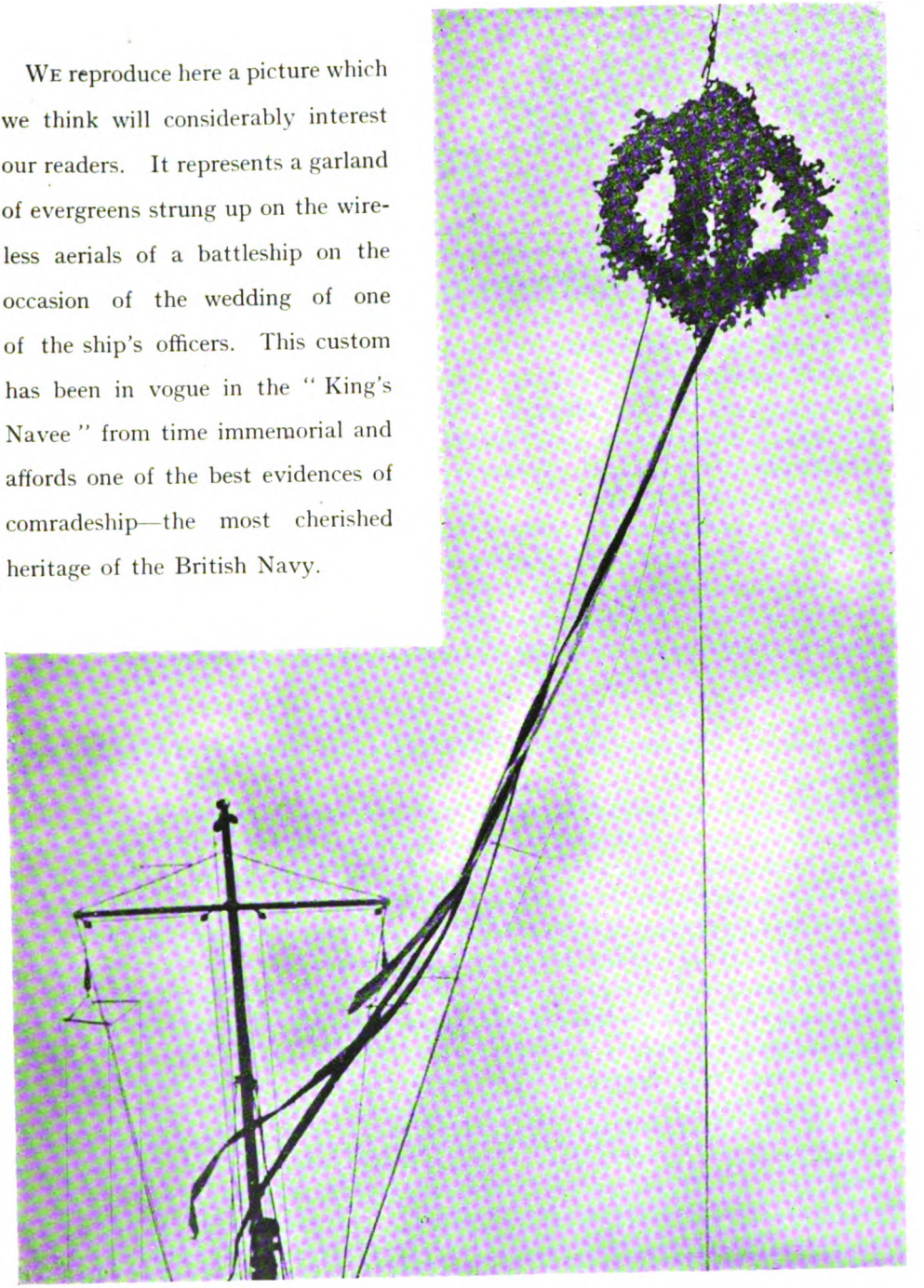

Photo by] [*Newspaper Illustrations.*

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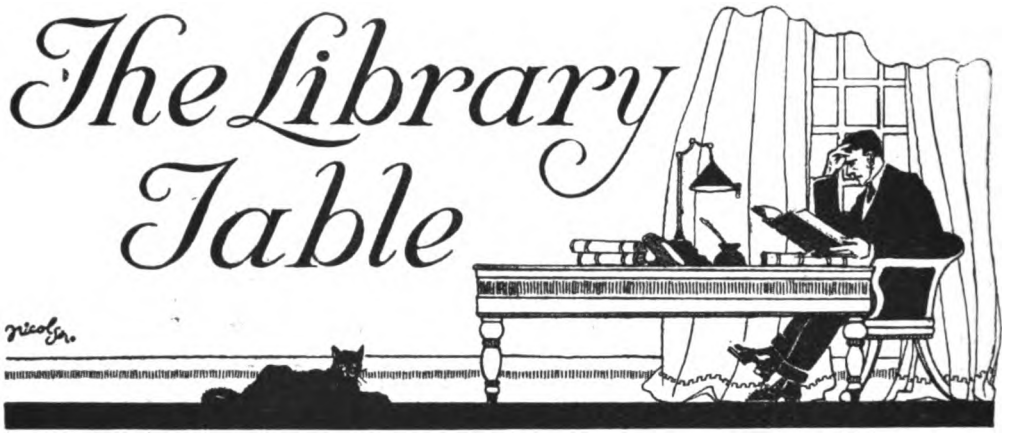
The Library Table



"FLEETS OF THE WORLD, 1916." Illustrated. London: Eveleigh Nash & Co., Ltd. 6s. net.

Nothing could be more indicative of final victory for the Allies than a perusal of this book. A comparison of the navies of the allied nations with those of the Central Powers shows without a shadow of a doubt on whose side the ultimate gain will rest. Apart from the lists of vessels belonging to the navies of the world, there is included a short glossary of naval terms, comparative tables of the guns and projectiles used by the great fleets, and a list of the ships lost in the great war from August 5th, 1914, to May 1st, 1916. The book was in print at the time of the great Jutland battle, but nevertheless the publishers have been able to insert a slip showing the comparative British and German losses. The book does credit to the publishers.

* * * * * *

"TALES OF THE FLYING SERVICE." By C. G. Grey. London: George Newnes, Ltd. 1s. net.

This little book, which has already reached a second impression of the first edition, records some adventures and humours of aerial warfare. Mr. Grey is just the man who should have written such a book. He is the Editor of our contemporary *The Aeroplane*, and in that capacity he probably has access to more definite and reliable information than would be the case with outsiders. Moreover, we have the satisfaction of feeling that every side of the subject receives fair treatment. Wireless telegraphy and aviation are so inextricably bound together that it is difficult to read of the one without thinking of the other. The book is worthy of more than a paper cover.

* * * * * *

"MAP OF THE WEST INDIES." Obtainable at the West India Committee, 15 Seething Lane, London, E.C. Price, 10s. 6d. mounted and varnished on rollers, 7s. 6d. in sheet form. Carriage and packing extra in both cases.

Since the opening of the Panama Canal the importance of the islands in the Caribbean Sea has enormously increased. A part of the ocean which in past years

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was a *cul-de-sac* has now become one of the main avenues of modern maritime trade. The significance of this is ably demonstrated by the fact that the majority of the islands and countries on the adjacent mainland have hastened to equip themselves with wireless stations of varying power. On the map under review these wireless stations are indicated, whilst the principal railways, sea distances in nautical miles, and coaling and oil stations are also shown. It is a clear and useful map, and does credit to the producers.

* * * * * *

"ELECTRICAL APPARATUS MAKING FOR BEGINNERS." By Albert V. Ballhatchet. London: Percival Marshall & Co. 2s. net.

Those amateur wireless enthusiasts who are in the habit of constructing their own apparatus are well aware of how much interest and sound instruction is obtained from the making of the various instruments. In the handbook before us the author describes how a large number of different pieces of electrical apparatus, such as the various types of primary cells, galvanometers, electro magnets, solenoids, electric bells, telegraph instruments and the like can be made. The instructions given are in every case thoroughly practicable, for all the pieces of apparatus described have, without exception, been constructed by the author in the manner explained. A number of excellent photographs afford a valuable aid to the reader and make clear those parts of the apparatus which cannot well be explained in the text. Students of wireless who cannot at present occupy themselves with their favourite hobby will be well advised to obtain this little book and attempt the construction of some of the apparatus described therein. We would particularly draw their attention to the measuring instruments, the understanding of which will greatly help them in their wireless work when the present restrictions are removed.

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"ALL THE WORLD'S AIRCRAFT, 1916." London: Sampson Low, Marston & Co., Ltd. 21s. net.

This is the seventh year of issue of this famous annual, and the publishers are to be congratulated on being able to place it upon the market at so difficult a time as the present. The book is divided into three sections: (1) Aeroplanes and Airships of the World, (2) Historical Ships of the Last Fourteen Years, and (3) the World's Aero Engines. The outstanding section is probably that dealing with the historical growth of aeroplanes and aviation generally. The book is profusely illustrated, and in addition a list of aviators who have received certificates granted by the Royal Aero Club of the United Kingdom is given, together with the date granted, the make of machine used, and the place where the airman qualified. Wireless telegraphy now forms so important a part of the equipment of the modern "flying machine" (either lighter or heavier than air) that we feel that our readers would do well to possess themselves of so exhaustive an epitome.

* * * * * * *

"AN INTERMEDIATE TEXT-BOOK OF MAGNETISM AND ELECTRICITY." By G. F. Woodhouse, M.A. Sedbergh: Jackson & Son. 6s. net.

This book, which claims to be intermediate between the many elementary

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and advanced text-books on the subject, possesses no particularly novel features, and has probably been based upon the experience gained by the author while acting as Senior Science Master at Sedburgh School. It is divided into three parts: Magnetism, Electricity and Electrostatics, and on the whole the subjects dealt with are clearly explained. In the portions devoted to wireless telegraphy, however, there are one or two points to which we would like to draw attention.

On page 169, in speaking of the work of Hertz, the author says "he used a coil "and spark gap as oscillator." This is not correct, as the coil formed no part of the oscillator, but merely afforded a source of high-pressure electricity. It cannot be too clearly impressed on students that the induction coil is not traversed by the oscillatory currents which flow across the spark gap. On the following page the diagram of the magnetic detector shows a number of totally unnecessary twists in the aerial and earth wires and in the telephone connections. These do not make the diagram any clearer, and are apt to lead the young student to think that no electrical connections can be made without first twisting the wire round a lead pencil to give it a curly appearance. On page 171 the following paragraph appears:

"Later improvements consisted in including a transformer or jigger, the "inductance of which is variable and allows tuning. In some systems the two "coils of the jigger (one in aerial circuit, the other in transmitting or receiving "circuit) are separate, as in a coil. In other systems the auto-transformer principle "is used. Variable condensers are also used, giving further opportunities for "tuning."

From this paragraph one would gather that the object of the transformer was merely to provide variable inductance in the aerial circuit; certainly there is nothing to indicate that it effected an improvement in allowing the energy to be passed from a closed oscillating circuit into an open radiating circuit. Altogether, from a learner's view-point, the paragraph is decidedly obscure.

In Appendix II, which claims to give practical details for the construction of a small wireless outfit, we find a description of a crystal detector which in practice would be found far from satisfactory; while the diagram of the receiving circuit on page 225 is not one which calls for high praise. In this the receiving transformer or tuning coil is shown to have no less than four sliders, the lower two of which are totally unnecessary. The variable condenser C, which from a remark on the previous page one would think was necessary for tuning, is placed in an apenodic circuit where no resonance effect is possible. With regard to the telephone receivers, it is said "in using crystal detectors, high-resistance telephones should be used, "about 4,000 ohms will be suitable." We agree that telephones of such a high resistance would work excellently; but few amateurs can afford to buy 4,000-ohm telephones. Splendid results can be obtained with a 2,000-ohm pair, which are quite good enough for use with the crude apparatus described. These, of course, can be obtained at a much lower price.

In the diagram of transmitting apparatus shown on page 223 there are two sliders shown on the auto-jigger, one of which is unnecessary.

From the above remarks the reader will see that wireless matters in this book are not so clearly dealt with as one would expect.

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Personal Notes

THE *Irish Times* recently contained the following paragraph :—

" The Earl of Meath, His Majesty's Lieutenant for the County of the City of " Dublin, has appointed Mr. John Mooney, C.V.O., J.P., of Eastwell, Palmerston " Park, Rathmines, in the County of Dublin, a Deputy Lieutenant for the County " of the City of Dublin."

Mr. Mooney was one of the early Directors of Marconi's Wireless Telegraph Company, and no doubt many of his old friends and acquaintances will be glad to learn of the promotion afforded to him by the Earl of Meath. We congratulate Mr. Mooney on being thus honoured.

* * * * * *

A month or two ago we reported that Mr. J. Jerritt, the Wireless Press representative in Plymouth, had been appointed lecturer and examiner to the Boy Scouts Association of that district. Mr. Jerritt now informs us that he has received the further appointment of examiner to the Mount Edgcumbe Training Ship.

* * * * * *

We have received news of the marriage of Mr. W. L. Cormack, who is stationed at a wireless station near Aberdeen, to Miss C. M. Bone, only daughter of Councillor R. H. Bone, J.P., of Scotsburn, Kildary, Ross-shire. Mr. Cormack will no doubt be remembered by many of our readers on the operating staff, having joined the Company's service at the beginning of 1910. Mr. Cormack has thus seen nearly seven years' service, six of which were put in on foreign service in Peru and India. On coming to England in January last Mr. Cormack entered the R.N.V.R., when he was posted to his present station. We offer Mr. and Mrs. Cormack our congratulations on the happy event.

* * * * * *

We have had a letter from Mr. A. E. Brown, who before the war was a wireless operator in Marconi's Wireless Telegraph Company, Limited, and who is now doing duty as a wireless operator in France. Mr. Brown has had a busy time, having been engaged on all classes of work, from heavy permanent lines to buried cable work.

* * * * * *

We have received a notice from Mr. J. R. Stapleton, the wireless operator at Welikada, near Colombo, Ceylon, Radio Station, of his marriage on July 29th last to Miss Myrtle Natal Borland, which took place at St. Peter's Church, Fort, Colombo. A wireless apparatus was erected on one side of the verandah, and Corpl. Dinwiddie had charge of it. It worked quite satisfactorily, and throughout the afternoon wireless messages were exchanged with the wireless station at Welikada. Mr.

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Stapleton has been a good friend and constant reader of our journal since its inception, and we are sure all our readers join with us in wishing Mr. and Mrs. Stapleton a long and happy life. A photograph of Mr. Stapleton and his staff appeared in our May, 1915, number.

* * * * * *

We regret to announce that the death took place recently in the naval hospital at Deal of Mr. George William Henderson. Death was due to pneumonia following a brief illness. The deceased, who was but twenty years old, was a first-class wireless operator attached to the Royal Naval Air Service at Dover. Shortly after war broke out he took up the study of wireless telegraphy and qualified at a naval college in Glasgow. He joined the R.N.A.S. in November, 1915, and after three months' training at Wormwood Scrubbs was posted to Dover. We offer our sincere condolences to his bereaved parents.

* * * * * *

We are sorry to record the death of Second Air Mechanic Albert Spencer, of Crawshawbooth, Lancashire. Mr. Spencer, who attained his twenty-fourth birthday whilst on active service in France, was a wireless operator when he received the wounds which proved fatal. He enlisted on September 21st, 1915, and left for France on March 18th last. Our sympathies go out to his young wife in her great bereavement.

* * * * * *

We regret to announce that Lance-Corporal W. A. Waterman, of the Essex Regiment, has been killed in action. He was a very smart man, and acted as advice clerk at the Chelmsford Works of the Marconi Company. He joined Kitchener's Army in December, 1914. He only married in the early part of last year.

* * * * * *

As we go to press we learn with deep regret that Private R. W. R. Fletcher, of D Co. Machine Gun Section, 17th Middlesex (Footballers), has died in France from wounds received in action. It seems that he was wounded by an explosion of a shell as his gun team was going through a trench in the advance of July 28th, and died two days later. Private Fletcher was a member of the Wireless Press staff—the third to lose his life in the war. Great sympathy is felt for his parents in their sad loss. We hope to give further particulars next month.

* * * * * *

Lieutenant Balcombe, late of the Traffic Department of Marconi's Wireless Telegraph Co., Ltd., continues to be very active on active service. He has now been appointed Lieutenant and Adjutant to his regiment—a very responsible position. For the benefit of readers who have not followed Lieutenant Balcombe's career, we would mention that this promising officer rejoined the Army as sapper at the outbreak of war, and has won his promotion step by step to the important position he now holds.

* * * * * *

We have to announce that Capt. W. H. G. Bullard, U.S.N., who has been Superintendent of the Naval Radio Service of the United States, has relinquished that position, and has been placed in command of the U.S.S. *Arkansas*. Commander D. W. Todd, U.S.N., has been appointed to succeed Capt. Bullard as Superintendent.

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We hope in a future issue to give a photograph and some biographical particulars of the latter gentleman.

* * * * * *

A general parade was ordered at the Wormwood Scrubbs Depot recently, when Captain Owen, R.M.L.I., Executive Officer, presented the Distinguished Service Medal to Petty Officer L. T. N. Sanderson, of the Wireless Telegraph Department. "Sandy," as he is affectionately known among his comrades, did the work of wireless operator at Anzac, and earned the decoration for operating there under practically continuous heavy shell fire during a period of five months. His coolness and courage attracted official notice, of which the ceremony was a fitting sequel. The Commanding Officer, in presenting the medal to P.O. Sanderson, said he was proud to make the presentation, and Petty Officer Sanderson's devotion to duty was a credit to the Service and also to the Section to which he was attached. We, in our turn, offer him our sincere congratulations.

* * * * * *

One of the saddest of the many sad incidents of this terrible war is the following: A lad named Cole, of Horsham, joined the Navy some time before the outbreak of war, and for four years served on board H.M.S. *Queen Mary*. When this ship was lost in the Jutland battle his relatives regarded him as lost. Judge of their joy, however, when a few days after the action a letter arrived from their son stating that he had been ashore for examination when the battle was fought. Unfortunately the parents' happiness was short-lived, for a notification was received from the Admiralty of the death of their son. Since writing to his father and mother he had been appointed to H.M.S. *Hampshire*, and with Lord Kitchener and nearly all the crew was lost off the Orkney Islands. By this accident a promising career was cut short, as young Cole had just satisfactorily passed his final examination in connection with wireless telegraphy.

* * * * * *

An unsurpassed deed of heroism has met with its due reward. No. A 24155, Private J. G. Hood, of the 3rd (formerly 5th) battalion (attached wireless section Canadian Corps H.Q. Sig. Corps), has been awarded the Distinguished Conduct Medal for conspicuous gallantry and devotion to duty. When his signalling station was wrecked he went with another man and assisted in serving the guns of a defence section of artillery which had had several casualties. Later he returned to his signalling station and destroyed the wireless instruments and codes in face of the advancing enemy, but unfortunately he was wounded by shrapnel. We offer him our sincere congratulations on the high honour bestowed on him.

* * * * * *

We are pleased to mention that Private H. F. Gill, of the wireless section, 4th Corps, has been awarded the Military Medal for good work at Vimy Ridge. Towards the end of May last all the land-lines gave way under the heavy bombardment by the Germans, and wireless became the only means of keeping communication open. Private Gill, who was in charge of the forward station, had his mast blown down twenty times through the night. The following day the Brigadier sent for him and expressed his pleasure at the way in which they had "carried on." Since then he has been presented on parade with the Military Medal Ribbon.

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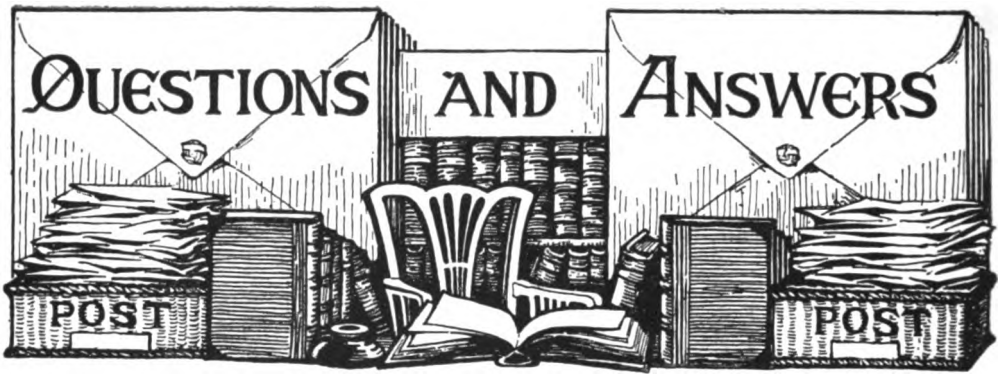

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

R. T. (Portsmouth).—The question you ask is quite outside of our province, but we would suggest that you apply to the shipping company in which your cousin is a captain, mentioning that you would like to obtain a position on the purser's staff, and asking whether they have any vacancies. There is usually a large waiting list for such positions.

"SPARKS" is informed that we cannot answer any queries unless the full name and address of the writer is forwarded as well as the *nom-de-plume*. If he will write to us again, giving the necessary particulars, we will be pleased to answer his queries.

J. E. H. (Bury).—After a student has gained his Postmaster-General's certificate, he should apply to the traffic manager, Marconi International Marine Communication Co., Ltd., Marconi House, Strand, London, W.C., stating his qualifications and asking whether there is any vacancy which can be offered to him. If the application is accepted, he is placed in the Marconi school for a period depending upon the extent of his knowledge, for a finishing training.

M. H. I. (Barnet).—(1) The di-electric constant of ebonite varies. Dr. Fleming, in his Pocket Book (page 339), quotes Rosetti as authority for the figure 2·05; Boltzmann for 3·15, Schiller for 2·21, and Elsas for 2·86. For general purposes it can be taken as about 2·5. (2) The resistance of Nr. 26 S.W.G. Eureka wire is 264·5 ohms per 100 yards, and of Nr. 28 S.W.G. 391·4 ohms per 100 yards. Thank you for your appreciation of our paper.

W. S. (Lennoxtown).—(1) An excellent book on elementary mathematics is that by Frank Castle entitled *Practical Mathematics for Technical Students*. This you can obtain from our publishers for 3s. 10d., post free. (2) It does not follow that if you join the Royal Flying Corps as a wireless operator that you would be taught aviation. Only a certain number of men are trained as pilots. (3) See the article which appears in this number on the training of radio-telegraphists for the Army and Navy. (4) This is a matter you should decide personally. (5) Applicants are not accepted for the marine operating staff of the Marconi Company above the age of 25.

M. B. (Alford).—There is an article in this issue which will give you all the information you require.

A. G. J. (Brisbane).—Many thanks for your letter, for the cutting enclosed, and your appreciation of our magazine. In reply to your query, arsenical compounds have been used in conjunction with crystals for wireless detectors, and with silicon especially, have given good results. We have not personally tried the combination of bismuth with silicon or pyrites, and are interested to hear that you obtained good results with it.

C. G. (Macao).—(1) The set which you mention cannot have been tuned at the time of installation, and if you get a 610 metre wave with the variable high-frequency sliding inductance at its lower value, the capacity of the condenser must be too large. This will have to be reduced. (2) The reason for the sparking between the protective points of the disc discharger, when you change over to a

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300 metre wave, is that the phase adjustment of your discharger is wrongly set for this wave. Try rocking the frame, holding the fixed electrodes. A slight movement in one direction or the other will put you right. (3) It is difficult to give the reason for the sparking at the micrometer gap of your receiver without inspecting the installation, but we should think that you are getting an inductive effect from the earth lead. Look to see whether any of the wires leading to the receiver run parallel with this lead, or with any part of the aerial circuit. An alteration of the position of the receiver and wiring may improve matters, but in any case, so long as you keep the micrometer gap very small, no harm should result.

E. R. (H.M.S. ——).—The automatic transmitter at Clifden can be set for any speed required within wide limits.

W. O. (Treorchy).—We are glad to hear that you are so interested in the science of wireless telegraphy. We are afraid the defect you mention would debar you from service with the Marconi Company's operating staff, and as this company controls the wireless apparatus on the great majority of British ships, including pleasure steamers, cross-channel steamers, and private yachts, you would stand little chance of obtaining employment as a wireless operator. Very few steamship companies employ their own wireless operators; they are mostly obtained from the Marconi Company. Thank you for your good wishes for our magazine.

G. T. B. (H.M.S. ——).—Have you the new edition of "Hawkhead's Handbook" revised by H. M. Dowsett? In this you will find the ½-kw. set and the balanced crystal receiver dealt with very clearly. There is no other book which contains so much information about the apparatus mentioned. It is dealt with much more fully in the second than in the first edition.

O. R. (Wolsingham) writes: "The peripheral speed of the rotary discharger on a 5-kw. apparatus is, I believe, very high, therefore the time taken for one of the studs to pass a fixed one—*i.e.*, the duration of the spark—must be very short, allowing only a few violent and highly damped oscillations to take place. The energy will be quickly transferred to the secondary circuit, but since the primary is no longer continuous, the spark surfaces having been widely separated, none will be retransferred to it by the secondary, hence most of the energy will be radiated into space. This being so, I fail to see the advantage of a *loose* coupling; on the contrary, it seems to me that a tight, or even direct, coupling would mean a decided gain in efficiency."

Answer.—Whilst it is true that the peripheral speed of this disc discharger is very high, it is not sufficiently high to open the circuit after one or two oscillations, when short waves are used. With the very long waves an especially high-speed disc is used by the Marconi Company for their Transatlantic working, and in their high-power stations for long-distance communication this "cut-out" effect is found, and as a consequence a tighter coupling can be used. We are sorry we have not any figures available at the moment to show the percentage of power radiated in the various sets you mention; a great deal depends upon the aerial and the earth, and whether the set is adjusted to give the best results. In reply to your third question we do not think the defect in your left eye is sufficiently serious to debar you from joining the Marconi Company as an operator. This would have to be decided upon your examination by the Company's doctor if you were accepted.

A. C. (Deauville).—(1) Inductively coupled receivers are used practically always in commercial wireless apparatus. With crystal detectors and comparatively short waves, such as are used for ship and shore communication, it is impossible to obtain enough inductance in the aerial circuit to make direct coupling satisfactory. This also applies to the valve and electrolytic detectors. The magnetic detector can be placed in series with the aerial and still give good results, as it is a current-actuated detector, but in this position sharp tuning is impossible. Where the magnetic detector is fitted, arrangements are made for placing it in series with the aerial when the operator is listening for general calls, and in an inductively coupled circuit when he desires to tune his receiver. (2) By far the most sensitive detector is the three-electrode vacuum valve, a modification of the well-known Fleming valve. (3) A coherer receiver properly made and suitably adjusted should enable signals to be recorded at the distance you mention from a powerful station, as the signals would be very strong. A much more reliable method, however, would be to use an S.G. Brown relay with a crystal receiver, or better still, two of such relays in series if a very powerful current was required. We regret that during the period of hostilities we cannot describe in detail how such circuits should be arranged. (4) The arrangement shown in your diagram would not be at all satisfactory. The purpose of the detector D. 1 is simply to rectify the current. The detector D. 2 in the second circuit, having no oscillatory current to rectify, would merely act as a needless resistance and reduce the strength of signals.

"Di-electric."—We have searched our books of reference carefully, and cannot find any reference to tests of the di-electric value of the material you mention. If we are able to obtain any figures, we will make mention of them in this column.

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J. C. (s'Gravenhage) asks for the correct formula to find the mutual inductance between two coils by measuring the inductance when they are connected in series, and then one reversed. The formula given in *The Wireless Year Book*, page 727, *i.e.*, $\frac{M=L_1-L_2}{2}$ is wrongly printed. When the two coils (say A and B) are joined in series with the currents flowing in the same direction, the total inductance of the circuit is L_A+L_B+2M. If the connections of one be reversed, the inductance is L_A+L_B-2M, so that the difference between these values is $4M$, according to the formula quoted by you from "Hawkhead's Handbook." When the coils are joined in series with the currents in the same direction, there will be a certain magnetic flux linked with A, due to its own current, which will be proportional to L_A, the self-inductance of the coil. There will be a certain flux due to the current in A, which is linked with B, which will be proportional to the mutual inductance between A and B. Similarly, for the current in B there will be a flux linked with A, equal to that linked with B due to A, so that the total flux in the combined circuit must be proportional to L_A+L_B+2M. On reversing B, the fluxes in the two coils due to their own currents are linked in the same direction relative to them as before, but the fluxes due to the current in the other coils will be linked in the opposite sense, or the total flux must be proportional to L_A+L_B-2M.

A. W. (Telegraph Department, Paddington) has worked out the value of the aerial tuning inductance of the plain tuner, and obtains a value of 580 microhenrys instead of 680 as engraved on the switch. The fact that you get the same result using three formulas shows that your working is correct. You have, however, taken a wrong value for the diameter of the former. It is not 6 centimetres, but 5·6 cm. (nearly) over the wire. Using this figure, the inductance of one coil becomes 920 microhenrys, or the two in parallel will give 460 microhenrys, neglecting the effect of mutual inductance between them, which would increase the total self-inductance. An actual measurement gives about 480 microhenrys, and hence the mutual inductance is almost negligible. The engraved value is therefore incorrect. Probably the winding on some occasion has been altered without the engraving being altered at the same time. The later instruments of the plain tuner type are now fitted with an aerial tuning inductance similar to that used in the multiple tuner, the value of which is approximately 4,000 microhenrys. (2) You are correct in assuming that in the example in Dr. Fleming's Pocket Book, on page 97, the second term in the brackets should be $\frac{4}{9\cdot425}\times\frac{1}{20}$, and not $\times\frac{1}{400}$ as printed.

C. G. W. (Balham) has made certain calculations with respect to an aerial which he had before the war, and asks to have them checked. Your calculation of wave-length and capacity of the aerial are approximately correct, although it would be instructive to obtain the latter value from the formulæ given in Professor Howes' articles in the December 1914, January 1915, and February 1915 numbers of THE WIRELESS WORLD. The inductance of an aerial is, however, given by the formula

$$\lambda_m=1200\sqrt{L_oC_o} \text{ and not}$$

$\lambda_m=1885\sqrt{L_oC_o}$, as is explained in the article, "The Calculation of Wave-length of Aerials," in the March 1916 number. The inductance will therefore be 23·5 microhenrys instead of 15 microhenrys. With regard to the inductance of the tuning coil required to tune the aerial to 2,500 metres, since the ratio of wave-length of aerial by itself to the required wave-length = 130/2,500, or nearly 1 to 20, the ordinary formula may be used as explained in the article referred to. The result, 5,490 microhenrys, is therefore correct. The tuning coil has been designed to have a much larger inductance than this, the value given by you being approximately correct, but a better method of calculation is given in the Instructional Article, No. X., on the Receiving Circuit. We make the inductance 24,200 microhenrys. Owing to the long wave which you were attempting to receive, it would have been wise to design a coil which was nearer the required value of inductance, using thicker wire in order to reduce the resistance as much as possible.

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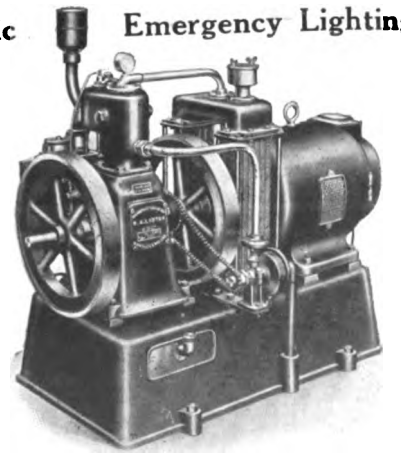

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A GLANCE at a map of the world on which is marked the distribution of vegetation will immediately reveal the fact that dense tropical forests occupy considerable portions of South America and Africa. India, too, has its fair share, together with a number of islands scattered throughout the Southern Pacific Ocean.

Now it happens in many cases that where these jungles exist there is also to be found immense natural wealth, be it in rubber, timber, copra, or other forms. Some of the most romantic adventure stories have been written around the exploits of early traders who, pushing their way towards the interior with a small following of trusted natives, succeeded in tapping a portion of this wealth, only to be plundered on their homeward voyage across the southern seas by the Barbary pirates, or cast on a desert shore.

The adventures of the modern trader are, perhaps, no less exciting, even if they have lost an element of the picturesque. No longer are great bales carried on the shoulders of weary slaves who wind their way down to the sea through the fevers and morasses of the dark continent, and rarely do we hear nowadays of a trader falling victim to wild beasts. The pioneer of to-day carries with him modern machinery by which great clearances are made, and, mile by mile, the ever-lengthening railway track provides an easy means of transport from settlement to sea.

In order that trade can be carried on to the best advantage some well-organised means of communication must be at hand, so that the inland trader may be able to keep in touch with his agents at the ports or in other settlements throughout the country. The days of the native runners who carried the letters in a cleft stick and who as often as not lost either the messages or themselves, is long since past, and nothing less than the almost instantaneous electric telegraph will satisfy the modern business man. As a consequence, thousands of miles of telegraph wire have been used to form a network of communication throughout equatorial and tropical regions. So long as these wires are able to carry messages everything is satisfactory, but, unfortunately, there are immense difficulties confronting the telegraph engineer who attempts to maintain a line through the jungle, and for days and sometimes for weeks on end the line is " down " and the trader isolated. It is because of these difficulties that the wireless telegraph is so rapidly displacing the wire telegraph in "jungleland," for the wireless telegraph can communicate across the jungle as easily as across the sea.

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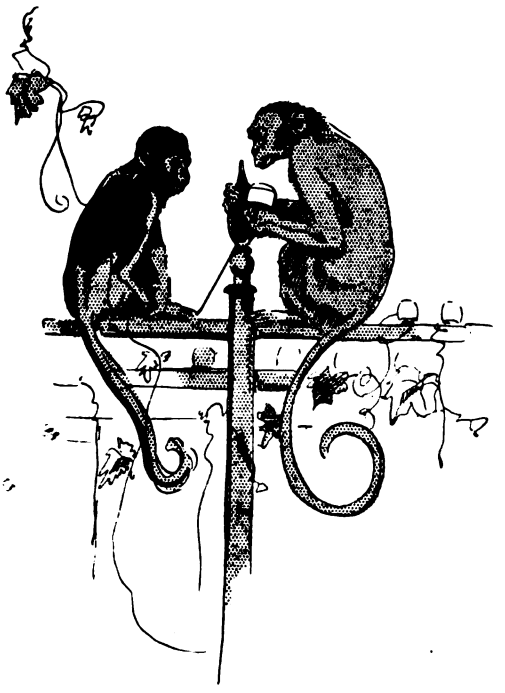
A little consideration of the problems which face the line telegraph engineer who is ordered to connect up two settlements separated, let us say, by a couple of hundred miles of dense vegetation will bring out very clearly the advantages of the wireless telegraph over its older brother. Having built his two terminal offices, with their equipment of telegraph instruments, the line engineer will have to survey the intervening country and decide the track to be taken by the long wire. This survey alone may take more than a year, and, in any case, considerable time will elapse before the first poles can be erected. It is obvious that it is not sufficient merely to dig a hole and plant a telegraph pole therein; a wide clearance must be made along the whole track, so that the wire may be clear of the surrounding trees and vegetation. Sometimes a mountain chain has to be crossed and frequently a wide detour has to be made to avoid the swamp or lake, for, of course, one cannot plant a pole in water or in any place where the foundation is insecure.



UNSCREWING INSULATORS IS GREAT FUN.

Clearing a path through the jungle for a mile is a work not lightly to be undertaken; clearing the jungle for 200 miles is a feat which taxes the ingenuity of the greatest civil engineer. And the task is not lightened or improved by the knowledge that new vegetation will sprout almost as fast as the old is cut down. Even when the almost insuperable difficulties of clearance have been overcome and an army of labourers are occupied for their whole time in keeping the track open, the telegraph engineer is still struggling with further problems and wishing he had never undertaken the task. There is, for instance, the comparatively small problem of poles. Sometimes, it is true, the ingenious engineer is able to utilise trees already in position to carry the wire, but in most cases poles have to be erected along a great proportion of the track. Generally, we may say a distance of 100 yards will separate these poles, although frequently they may be only half this distance apart. Even if we assume but 20 poles to the mile, and if again we make our track quite straight between the two points and allow for no detours, there are four thousand poles to be provided!

Our worried engineer, for his telegraph posts, can now choose between metal and wood. Each substance has its disadvantages. Metal will corrode and rust away in the hot, damp mists arising from the swamps; wood, on the other hand,

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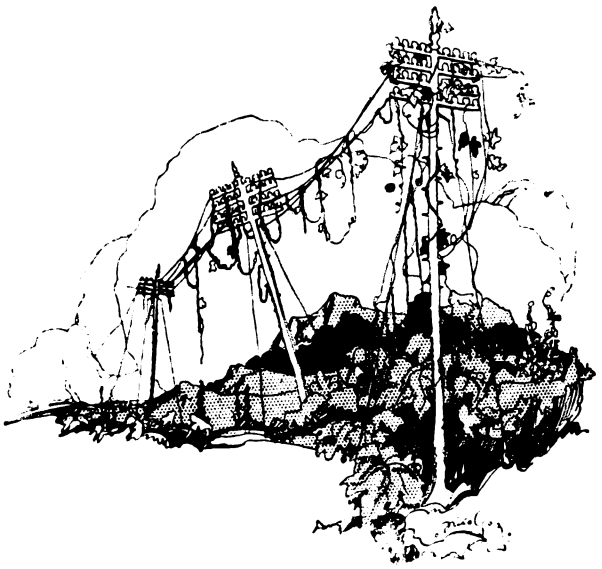


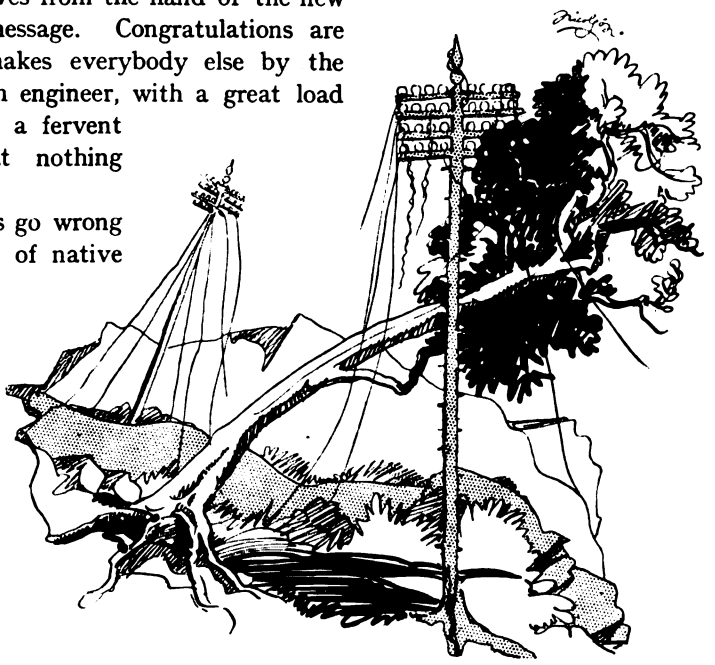
THE CREEPER IS PRETTY BUT INEFFICIENT.

will sooner or later fall a prey to the innumerable insects which bore their way even into the living trees.

Innumerable patents for making wood poles proof against the ravages of insects and rot have been taken out and processes tried, such as impregnation with creosote, but the trouble still exists, even if it has to some extent been reduced.

Once the posts are in position (and the engineer will heave a sigh of relief when this part of the work has been completed), insulators must be fitted to keep the wire away from the wood or metal supports, and finally the wire itself has to be fixed in place. The instruments will now be connected at the terminal station, and the patient trader, delighted to be rewarded for his long period of waiting, receives from the hand of the new telegraphist the first message. Congratulations are exchanged, everyone shakes everybody else by the hand, and the telegraph engineer, with a great load off his mind, sends up a fervent prayer to heaven that nothing may go wrong.

But something does go wrong inevitably. The patrol of native linesmen whose duty it is to see that the wire is kept clear from obstruction, is new to its work and fails to notice how thousands of little forest spiders, building cosy little nests in the hoods of the insulators, are spreading a film of gossamer over the surface of the porcelain and along the



FALLING TREES ARE A FREQUENT SOURCE OF TROUBLE.

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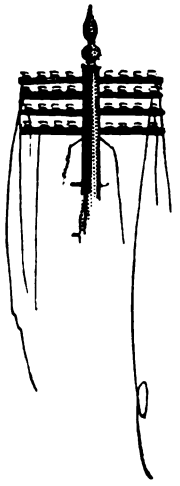

wire. These tiny threads are invisible from ground level, and the insulator will appear to be in perfect condition, but directly the heavy dew rises, the whole surface will be covered with a film of moisture in the form of tiny globules, such as one sees on any misty morning on a spider's web in the garden. As soon as this happens all insulating properties are gone and the line becomes "dead" to all traffic.

While a gang of linesmen are busy evicting the spiders from their new homes, a happy family of monkeys forty or fifty miles away are perhaps using their best endeavours to unscrew the insulators in a quiet part of the jungle. It may be very amusing, but it does not make for efficiency!

If fortune should favour our friend the engineer communication may be re-established in a few days when some of these minor faults have been traced and remedied. But he will be an extremely lucky man if he misses trouble with falling trees, which may break the wire and uproot half a dozen poles at a time.

Day by day the forest creeper will be putting forth its tendrils, embracing the poles in its growth and covering them, even as it covers the dead tree trunks, with a layer of delicate green. Gangs of linesmen will be occupied in cutting down this plant, which, if once it reaches the wire, will conduct the current to the ground and stop communication. The undergrowth, sprouting fast, will threaten to choke the track in a wonderfully short time, and any section left for more than a week or two will appear even as the virgin forest.

More pages than are contained in this magazine could easily be occupied in recounting the hundred and one difficulties of the wire telegraph in jungleland. The few we have already mentioned will serve to indicate to some extent what has to be faced when such lines are erected. We have so far made no reference to the predatory instincts of the wily native, who knows of no better substance than telegraph wire for making elaborate bangles, earrings, and other ornaments. It is a common occurrence in Africa to find whole stretches of the line cut away and stolen by the blacks, and, as a linesman cannot be in two places at once, such robberies are hard to detect. Wild animals are not behindhand in aiding the natives to ruin this frail system for linking up the distant communities. It needs to be a very strong pole, and still stronger wire, which will stand up to a charging elephant, and a crowd of monkeys holding earnest consultation on the stretch of wire between two poles is no light weight to support!

THE NATIVE EXHIBITS A FONDNESS FOR WIRE.

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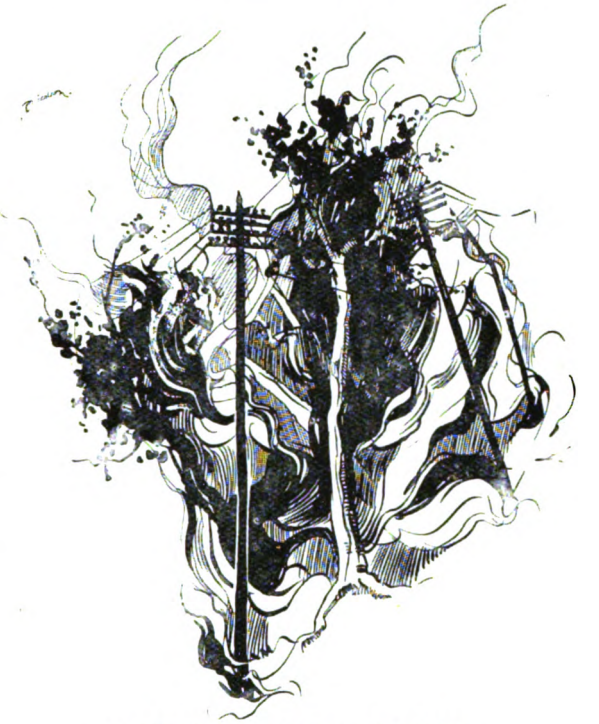
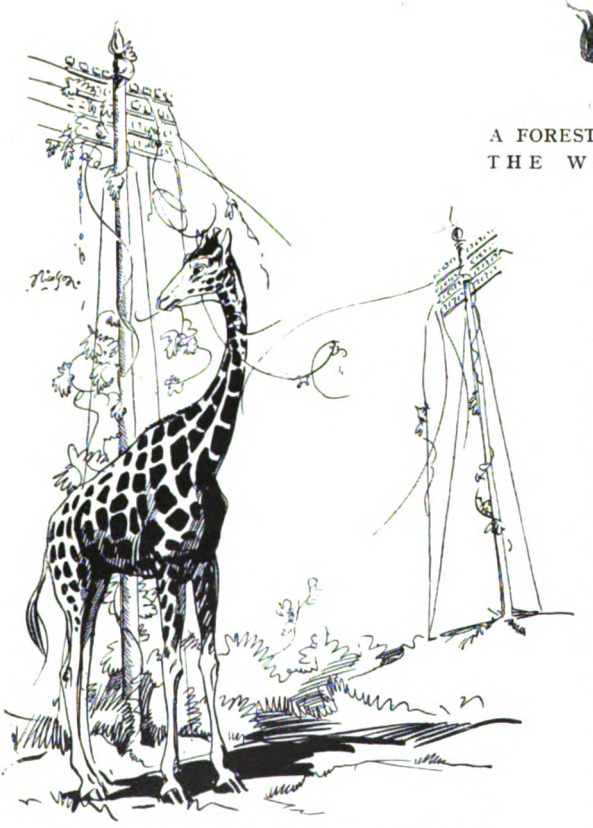
If all the troubles above detailed have been avoided (and it is certain that some are bound to come the way of the worried engineer), there still remains the ever-present danger of the forest fire, which in its relentless progress may destroy at the same time half of the system and the work of years.

Let us now see how admirably the wireless telegraph serves as a means of communication in these tropical regions. Considering again our imaginary case of two communities separated by a distance



A FOREST FIRE MAY DESTROY THE WORK OF YEARS.



IN SOME REGIONS WILD ANIMALS ARE VERY TROUBLESOME.

of 200 miles, we have no long pole line to worry about and no winding track through the jungle. If it is decided to erect a wireless telegraph system the Marconi engineer will inspect the ground at each terminal and quickly decide upon suitable sites. In most cases there will be sufficient open ground near the townships (only comparatively small areas are required), but, even if a site has to be cleared in the jungle, the space needed is so small that the whole preliminary work can be quickly carried out. Experience will immediately indicate what power and type of station are required, and in a short time a neat station

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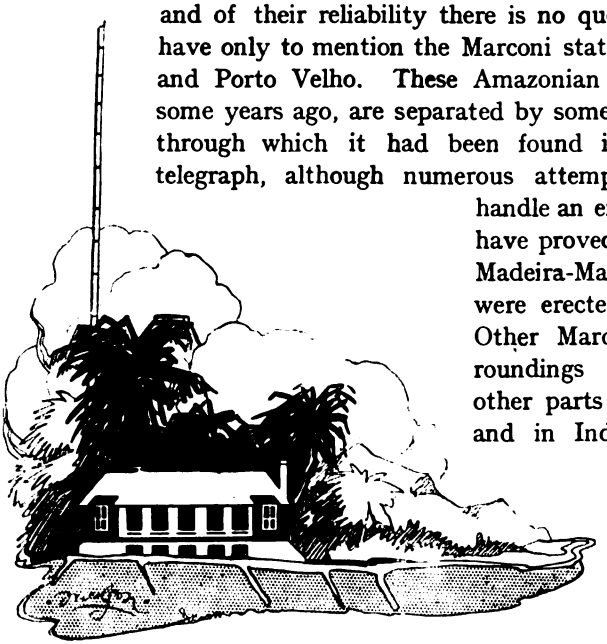
building will be erected with accommodation for the instruments and the staff. Tall steel masts, arriving in sections and merely requiring bolting together, will soon rear themselves above the sea of trees, and in a shorter time than the wire telegraph engineer would take to make his preliminary plans the new wireless station will be ready to work. No falling trees or charging animals can break down the system, for the messages will be flashing through the ether unhindered, and with the speed of light. The myriad of insects boring their way through rotting wood will now be left undisturbed; no army of linesmen will patrol the malarial swamps of the primeval forest; the worst that could happen would be a severe atmospheric storm, which might interrupt communications for a few hours, but even this trouble will probably be overcome before long.

Wireless in jungleland is no new proposal. Very many stations are now working in various parts of the world in conditions every whit as difficult as those described in this article. Success has invariably attended them. It is as easy to erect a pair of stations to communicate over a thousand miles as over a couple of hundred, and of their reliability there is no question. As a typical case we have only to mention the Marconi stations now operating at Manaos and Porto Velho. These Amazonian stations, which were erected some years ago, are separated by some 700 miles of tropical forest through which it had been found impossible to carry the wire telegraph, although numerous attempts had been made. They handle an enormous volume of traffic and have proved of the greatest value to the Madeira-Marmoré Railway, for which they were erected by the Marconi Company. Other Marconi stations in similar surroundings are working successfully in other parts of South America, in Africa, and in India, and the day is not far distant when this form of communication will rule supreme throughout the jungle. The old and abandoned wire telegraph, with its rotting and creeper-covered poles, will then be left to the denizens of the forest.



THE WIRELESS MAN, IN HIS SNUG LITTLE STATION, CAN WORK UNHINDERED AND UNWORRIED.

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Wireless Training in Canada

The Canadian Marconi Company's School in Montreal.

WE reproduce below a photograph of one of the classrooms of the new Marconi school in Montreal. The school was opened on June 1st last, and is proving very successful. Mr. Douglas R. P. Coats, the instructor in charge, is well known to many of our readers by his contributions to THE WIRELESS WORLD, and is seen in the photograph standing behind the back row of students.

In order that the training in reception may be made to resemble as closely as possible actual working conditions, specially designed apparatus and circuits have been fitted, together with automatic transmitting devices. The latest type of 1·7 kw. apparatus is available for the instruction of students in the handling of the actual apparatus, and other installations will be fitted as required.

Mr. Coats informs us that he will be delighted to show the school to any Marconi operators who may happen to find themselves in Montreal with an hour or two to spare.

INTERIOR OF THE MARCONI COMPANY'S TRAINING SCHOOL IN MONTREAL, CANADA.

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PERSONALITIES IN THE WIRELESS WORLD

Photo] [Harris & Ewing.

DR. LOUIS W. AUSTIN

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TO all who follow the technical progress of wireless telegraphy the name of Dr. Louis Winslow Austin will be very familiar. Dr. Austin, who holds the important position of head of the United States Naval Radio-telegraphic Laboratory at Washington, is the son of Professor L. A. Austin, of Middlebury College. He received his education at Middlebury College, Clark University, and the Universities of Strassburg and Berlin. For a time Dr. Austin acted as Assistant Professor of Physics at the University of Wisconsin, and later took up a position on the staff of the Physikalisch-Technische Reichsanstalt, Berlin. In 1908 he was appointed to his present position, where he has proved of the greatest service to his Government in the many researches and investigations which have been officially undertaken.

At the International Radiotelegraphic Congress of London, Dr. Austin was one of the United States representatives, and he has many friends among the wireless workers in this country. He was President of the American Institute of Radio Engineers for 1914 and has been a frequent contributor to the Proceedings of that Society.

Dr. Austin is specially interested in quantitative high-frequency measurements, and has spent a considerable time in carrying out tests between the well-known stations at Arlington and Darien. In a highly interesting paper recently presented to the Institute of Radio Engineers under the title of "Experiments at the U.S. Naval Radio Station, Darien, Canal Zone," he gave the results of some of these tests, and added much to our knowledge of long-distance communication.

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Some Characteristic Curves of a Poulsen-Arc Generator

By N. W. McLACHLAN, B.Sc.Eng., A.M.I.E.E.

Read 7th September at Newcastle-on-Tyne, before Section G of the British Association.

Introduction.

It has been shown by Mercer * that with a carbon-copper arc burning in an atmosphere of hydrogen, without a magnetic blast, having a condenser (the capacity not exceeding a certain limit) and a variable inductance shunted across its terminals, there is a certain inductance, and, therefore, frequency, for which the shunt current is a maximum. The present investigation was undertaken to determine whether this condition is applicable in the case of a Poulsen-arc generator: (1) When energy is absorbed in the shunt circuit by a variable non-inductive resistance; (2) when the energy absorbed in the shunt circuit is as small as possible. In both these cases there is a loss in the Moscicki condensers, this being unavoidable, unless air condensers are used. (*See* Appendix.)

Methods of Measurement.

The main and shunt circuits of the Poulsen generator were arranged as shown in a recent Paper by the author.† The test ring and the rheostats were removed and a sandstone resistance moistened with copper sulphate solution was connected between the variable inductance and the primary of the current transformer (*see* Fig. 1 in Paper, *loc. cit.*). This type of resistance is constant in magnitude and inductionless at high frequencies.‡ The resistance could be altered by varying the amount of moisture in the sandstone or the distance between the copper plates to which the terminals were soldered. An iron-cored (stalloy discs) current transformer § was arranged to obtain a transformation ratio of 100 : 3 or 100 : 1, so that shunt currents up to 10 amperes could be measured.

Voltages greater than 40 volts were measured by an electrostatic voltmeter connected across the terminals of the sandstone resistance. The capacity current of the voltmeter was small, and since it was 90 deg. out of phase with the current through the sandstone, its effect on the shunt current could be disregarded. For voltages less than 40 volts a hot-wire instrument was used, the small errors of which at the frequencies employed in these tests, were found by the method detailed in the author's Paper to which reference was made above. In this case the total power

* F. Mercer, "The Arc as a Source of Oscillations," *Proceedings of the Physical Society*, London, Vol. XXVI., p. 372, 1914.

† N. W. McLachlan, "An Investigation into the Magnetic Behaviour of Iron at very High Frequencies with the Aid of a Poulsen-arc Generator," *Journal I.E.E.*, Vol. LIV., p. 480, 1916.

‡ *See* Paper by author, *The Electrician*, Vol. LXXVI., p. 875, March 24th, 1916.

§ A. Campbell and D. W. Dye, *Proc. Roy. Soc.*, "A" Vol. XC., 1914; also McLachlan, *loc. cit.*

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expended between the terminals of the sandstone resistance was taken—*i.e.*, power to voltmeter + power to sandstone. The frequency of the oscillations in the shunt circuit was measured, as in the other experiments (*loc. cit.*), by means of a Lorenz wavemeter. Frequencies between $1{\cdot}3 \times 10^5$ and $8 \times 10^5 \sim$ per second were employed, the range of frequency in any experiment depending on the magnitude of the capacity.

Keeping the frequency and the capacity constant, the following readings were taken for different values of the resistance in the shunt circuit (including resistance of connecting wires and inductance):

1. Direct current supplied to generator.
2. Current in shunt circuit (R.M.S.).
3. Voltage on arc (excluding ohmic drop in magnetising coils) (R.M.S.).
4. Voltage across terminals of sandstone resistance in shunt circuit (R.M.S.).

Sets of readings were taken of the same quantities at various frequencies. The whole of the foregoing procedure was repeated with several different capacities. The resistance used varied from 70 ohms to 6 ohms, and the capacity from 0·0009 mfd. to 0·009 mfd.

STRENGTH OF THE MAGNETIC BLAST.

The field strength at the centre of the gap where the arc was formed between the electrodes—*i.e.*, the strength of the magnetic blast—was measured by using a narrow search coil of small resistance wound on an annular groove cut in the centre of a wooden bobbin. The bobbin was securely fixed between the conical pole-pieces of the electro-magnet, and the ends of the coil were connected to the terminals of a Grassot fluxmeter, the deflection being observed on reversal of the current through the field coils. The search coil was calibrated, using a mutual inductance and a ballistic galvanometer. Although the reading of a fluxmeter with a sufficiently long period and weak control is almost independent of the time taken for the flux linkages through the magnetic circuit to change, the time of reversal of the current was reduced by connecting the magnet-coils to a 240-volt circuit, the excess voltage being taken up by a non-inductive rheostat. Details of the conical pole-pieces and a curve connecting the field strength in the gap and the magnetising current in the field coils are shown in Fig. 1. The angle of the cones is

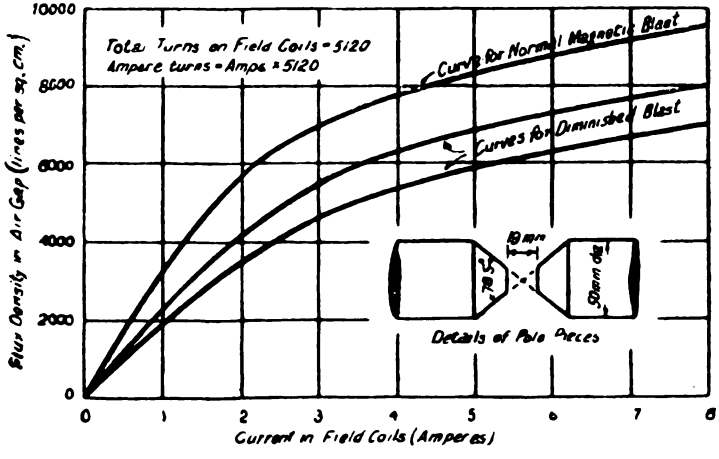

FIG. 1.—CURVES SHOWING THE RELATION BETWEEN THE FLUX DENSITY IN THE GAP AND THE CURRENT THROUGH THE FIELD MAGNET COILS.

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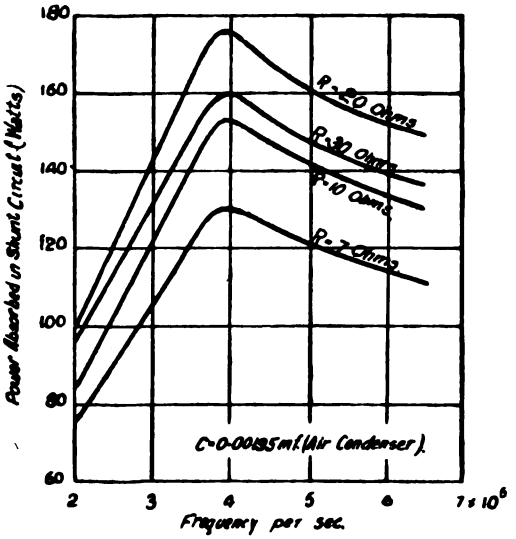

FIG. 2.—CURVES SHOWING THE TOTAL * POWER ABSORBED IN THE SHUNT CIRCUIT AT DIFFERENT FREQUENCIES FOR VARIOUS VALUES OF THE RESISTANCE AND A CAPACITY OF 0·00195 MFD.

* The curves showing the power obtained from "oscillations of fundamental frequency" for a capacity of 0·00195 mfd. are almost identical with those shown in Fig. 2, excepting that for frequencies greater than $4 \times 10^6\sim$ the ordinates of the former curves are slightly smaller than those of the latter. An agreement of a similar nature exists between the corresponding sets of efficiency curves.

such as to produce a fairly uniform magnetic field in the gap.*

ANALYSIS OF SHUNT CURRENT.

The current in the shunt circuit was analysed, using the method described in the author's Paper.† For the various capacities tested the most prominent harmonic was the second, other harmonics being comparatively small. With a capacity of 0·00924 mfd. the R.M.S. values of the second and third harmonics were, respectively, 30 per cent. and 9 per cent. that of the fundamental when the frequency was $3 \times 10^5\sim$ per second.

With capacities of 0·00924, 0·00368 and 0·00195 mfd. the second harmonic increased with decrease in inductance, and therefore increase in frequency. With a capacity of 0·00091 mfd. the second harmonic was practically non-existent at all frequencies. It was difficult to measure the harmonics to any degree of accuracy, especially when the ratio L/C was small. In this case the number of turns of the variable inductance in circuit was small, and in order to obtain sufficient energy in the wavemeter circuit, to secure reliable readings, the coupling between the two circuits must be fairly close. Under this condition the maximum value of the current in the wavemeter circuit (as read on the thermoammeter) was not always sharply defined, and the frequency of the oscillations could not be definitely determined. Since the distance between the inductances in the shunt and wavemeter circuits was small, it is probable that the mutual reactions of the oscillations in these circuits would affect the frequency. Moreover, it was impossible in some cases to analyse the shunt current. The magnitude of the harmonics compared with the fundamental depends to a certain extent on the length of the arc, the condition of the copper and graphite electrodes ‡ and the ratio of the shunt current to the arc current.§ (This ratio for given conditions is partially dependent on the length of the arc.) This ratio increases with increase in capacity, and the magnitudes of the second and other harmonics, compared with that of the fundamental, increase with the capacity. Throughout the experiments the arc length was adjusted to

* *See* J. A. Ewing, *Magnetic Induction in Iron and other Metals*, Third Edition, p. 148.

† *Loc. cit.*

‡ The second harmonic is more prominent when the graphite is badly burnt and the arc is burning irregularly. Both electrodes should have sharp edges.

§ McLachlan, *loc. cit.*

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obtain maximum current and power in the shunt circuit for good burning. The graphite was carefully ground up for each set of observations, so that the burning was as steady and quiet as possible.

Observations were also made of the effect of resistance in the shunt circuit on the harmonics—*i.e.*, the effect of absorption of power in the shunt circuit. It was found that with a capacity of 0·00924 mfd. the resistance in circuit had no appreciable effect on the harmonics. With capacities of 0·00195 mfd. and 0·00368 mfd. the effect of resistance was to increase the second harmonic, chiefly at the higher frequencies.

Results of Experiments.

Figs. 2 and 3 show the power absorbed in the shunt circuit plotted against the frequency for capacities of 0·00195 mfd. and 0·00924 mfd. and different values of the total resistance, including I^2R losses. In Fig. 2 each curve has a maximum ordinate, which shows that, with fixed capacity and resistance, there is a certain inductance, and therefore frequency, for which the power absorbed in the shunt circuit is a maximum. In Mercer's experiments the power absorbed in the shunt circuit was small (I^2R and condenser losses), and the curve showing the relation between shunt current and frequency was peaked like a resonance curve, there being more than one peak in certain cases. The direct current voltage used was almost double that in the present experiments, being 475 as against 240. The absence of a sharply defined peak in the current and power curves obtained in these experiments is probably due to the effect of the magnetic blast and to the fact that the direct-current voltage across the arc is least when the shunt current, and, therefore, the power, is a maximum, owing to the increased volt drop in the field coils.

With large values of the capacity say, 0·00924 mfd., the curves, as plotted in Fig. 3, have no maximum values for the range of frequency used in the tests; but the power gradually increases with the frequency. Curves showing the relation between the frequency and the power obtained from oscillations of fundamental frequency for a capacity of 0·00924 mfd., appear to have a maximum value between $f=2{\cdot}5\times10^5\sim$ and $3{\cdot}5\times10^5\sim$ per second. At the latter frequency, however, L/C was small, and the arc did not burn regularly, making it impossible to obtain reliable readings of current and voltage, or to analyse the shunt current accurately.

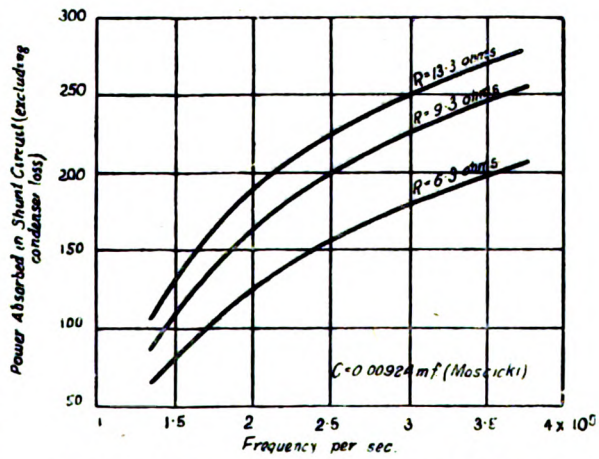

FIG. 3.—CURVES SHOWING THE POWER (FROM OSCILLATIONS OF FUNDAMENTAL FREQUENCY AND THE VARIOUS HARMONICS) ABSORBED IN THE SHUNT CIRCUIT AT DIFFERENT FREQUENCIES FOR VARIOUS VALUES OF THE RESISTANCE, AND A CAPACITY OF 0·00924 MFD.

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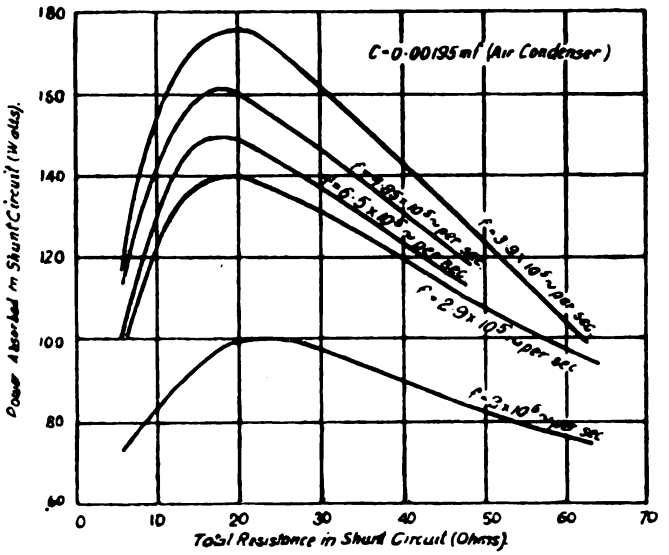

FIG. 4.—CURVES SHOWING THE TOTAL POWER ABSORBED IN THE SHUNT CIRCUIT PLOTTED AGAINST THE RESISTANCE FOR DIFFERENT FREQUENCIES, AND A CAPACITY OF 0·00195 MFD.

The curves in Fig. 4 show the power obtained with various resistances plotted against those resistances for different values of the frequency. When the resistance is small the curves rise quickly, reaching a maximum value; as the resistance increases the curves fall away more gradually. Hence there is a definite resistance, for which the power absorbed in the shunt circuit is a maximum. For large capacities (0·00924 mfd.) the curves are more flat topped.

With a fixed resistance in the shunt circuit the power absorbed at any given frequency increases with the capacity. If, however the ratio L/C is small, the burning of the arc is not so regular as it would be with a smaller capacity and a reduced output.

The curves showing the relation between the direct current supplied to the generator and the frequency, for a given resistance in the shunt circuit, are similar in shape to those in Fig. 5. The maximum value of the direct current supplied to the generator corresponds to maximum shunt current and to minimum voltage across the arc. The reason for the simultaneous occurrence of maximum shunt current and minimum voltage across the arc is probably due to the increased ohmic volt drop in the field coils (which are in series with the arc), due to the direct current being a maximum, thus reducing the direct-current voltage across the arc.

The strength of the magnetic blast was lessened by making an air-gap between the top of the electromagnet, carrying the conical pole-pieces, and the two vertical limbs on which the field coils were wound. By this means it was possible to ascertain the performance of the generator with different strengths of magnetic blast, without altering the resistance of or the number of turns on the field coils. Two different field strengths were employed, the characteristics being shown by the two lower curves in Fig. 1. A diminution in the strength of the blast did not cause any appreciable alteration in the fundamental frequency of the oscillations in the shunt circuit; but there was an increase in the second harmonic with the larger capacities (0·00368 mfd.) and small inductances. For any given resistance in the shunt circuit the power obtained at the lower frequencies was increased (owing to increased direct current supplied to the generator), the maximum value occurring at a lower frequency than with the normal blast—*i.e.*, the curves in Fig. 2 were shifted horizontally

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backwards. The maximum power and the corresponding efficiency of the arc were almost the same as the values obtained with normal blast.

It has been shown by Poulsen * that the amount of energy radiated from an antenna is increased considerably by using a magnetic blast. No details, however, are given regarding the strength of the blast.

A resistance of 20 ohms in the shunt circuit with a diminished blast caused very unsteady burning at the higher frequencies. At the lower frequencies the burning was improved by diminishing the blast. If, however, the blast is diminished beyond a certain value, the burning is unsteady. With normal blast the oscillations were irregular and the burning noisy when the resistance in the shunt circuit was large enough to cause a substantial reduction in the shunt current. This was especially the case when the ratio L/C was small.† Without the blast, and with resistance in circuit, oscillations could not be obtained. This confirms observations made by Austin, using an arc without a magnetic blast burning in an atmosphere of hydrogen.‡ With diminished blast and zero sandstone resistance the maximum value of the shunt current (capacity = 0·00195 mfd.) occurred at a lower frequency than with the normal blast, and the curves showing the relation between the shunt current and the frequency were shifted backwards relatively to those shown in Fig. 5. There was only a slight difference between the maxima currents for different strengths of the magnetic blast as indicated by the curves in Fig. 1. The burning of the arc was more regular at the lower frequencies, but less regular at the higher frequencies with diminished blast. At the lower frequencies the active length of the arc was greater, but the proportionate variation in the shunt current and in the direct current, caused by an alteration in the arc length, was less than with the normal blast. If, at the lower frequencies, the blast was decreased beyond a certain value (smaller than the values indicated by the curves in Fig. 1), the burning was irregular. It is possible, therefore, to maintain the shunt current approximately constant and the burning regular over a fairly wide range of frequency by suitably varying the strength of the magnetic blast.

(To be continued.)

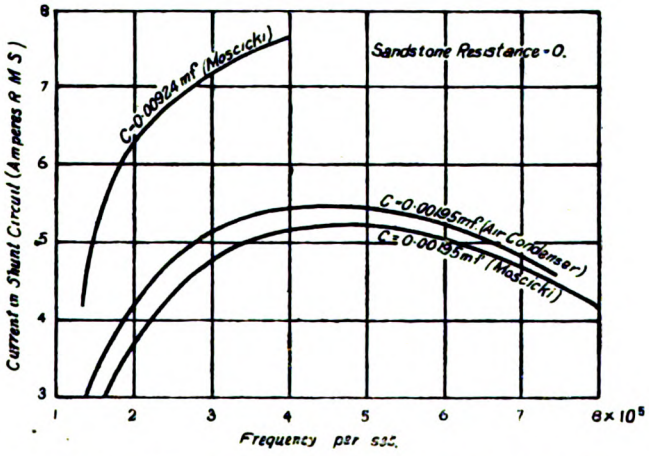
Current in Shunt Circuit (Amperes R M S)
Frequency per sec.
Sandstone Resistance - 0.
C = 0·00824 mf (Moscicki)
C = 0·00195 mf (Air Condenser)
C = 0·00195 mf (Moscicki)
8 x 10⁵

FIG. 5.—CURVES SHOWING THE CURRENT IN THE SHUNT CIRCUIT PLOTTED AGAINST THE FREQUENCY FOR DIFFERENT VALUES OF THE CAPACITY, THE RESISTANCE OF THE SANDSTONE BEING ZERO.

* V. Poulsen, "A Method of Producing Undamped Electric Oscillations and its Employment in Wireless Telegraphy," *The Electrician*, Vol. LVIII., p. 166, 1906.

† V. Poulsen, "Production of Continuous Electrical Oscillations," *Trans. Int. Cong.*, St. Louis, Vol. II., p. 963, 1905; also *Science Abstracts*, 1620 A, 1905.

‡ "On the Production of High-frequency Oscillations from the Electric Arc," *Bulletin of Bureau of Standards*, Vol. III., No. 2, 1907; also *The Electrician*, Vol. LIX., p. 632, 1907.

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Digest of Wireless Literature

A "Wireless" Organ.

The *Wireless Age* for September contains an article on "The Desilets Wireless Organ," invented by the Rev. Georges Desilets, of Nicolet, Quebec. It operates on the principle of the rotary spark-gap, the note of which, it is well understood, depends mainly upon the number of sparks made per second. In the simplest form of the Desilets apparatus eight rotary spark-gaps emitting notes corresponding to the musical octave are mounted on a single shaft, which is revolved by a motor. The current is switched through one or more of the gaps by means of an arrangement like a piano keyboard.

The inventor writes that this music has been heard by trans-Atlantic liners in the St. Lawrence River and by the Marconi stations at Montreal, Three Rivers, and Quebec. At present, however, his set is silenced by the war regulations.

Ordinary wireless sending and receiving apparatus is employed, except that in place of the ordinary sending key a plurality of keys are employed, the operation of any one of which will cause a certain musical note to be transmitted, different notes being obtained according to which key is operated. The various musical notes are obtained through the medium of annular rows of rotating spark-gaps, each row producing sparks of greater or less frequency than the adjacent rows. A most convenient way of obtaining this result is to provide the annular rows of spark-gaps in the form of points or studs projecting radially from the surface of a conical or frusto-conical rotor, the points in one row being the same distance apart as the points in any other row. Thus the points in the row of greatest diameter would be more in number and would travel at a greater speed than the points in the row of smallest diameter and produce sparks with greater rapidity. In order to produce a regular scale of musical sounds the number of points on each row is determined by the following relation between the number of points in two adjacent rows well known in acoustics:

1, 9/8, 5/4, 4/3, 3/2, 5/3, 15/8, 2

The invention will be better understood with the aid of the accompanying drawing, which illustrates a diagrammatic view of the apparatus.

The points belonging to each of the annular rows and the different rows before mentioned are electrically connected to each other and to the shaft, 2. Further, the points of one row are the same distance apart as the points on the other rows, and as an example it may be mentioned for purposes of comparison that, if the row 3 contains twenty-four points, the row 4 contains twenty-seven, the row 5 thirty, the row 6 thirty-two, the row 7 thirty-six, the row 8 forty, the row 9 forty-five, and the row 10 forty-eight, according to the relation before mentioned.

The points form poles and operate in conjunction with a plurality of fixed poles, 11, 12, 13, 14, 15, 16, 17 and 18, one for each row of spark-gaps, and carried by a suitable insulator, 19, provided with terminals, 20, to which and the fixed poles are connected electric wires, 21, leading from the keyboard, 22.

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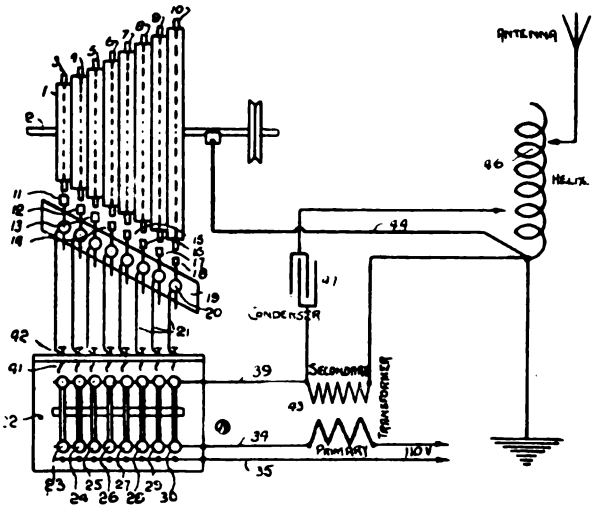

The keyboard, 22, comprises a set of keys, 23, 24, 25, 26, 27, 28, 29 and 30, each of which is pivoted intermediately to a fixed wooden bar, 31. The underside of the outer end of each key carries a contact, 32, electrically connected by means such as the spring, 3, to one of the wires, 34, of the line circuit and the other wire, 35, of the line circuit being provided with a contact, 36, beneath each key, adapted to co-operate with the contact, 32, to close the line circuit. Both ends of a key are insulated from each other by the joining arm made of suitable insulating material.

The outer end, 37, of each key is provided with a contact, 38, at its upper end, which is also connected beneath the key to one of the high tension wires, 39, by means of the spring, 40. Forty-one are spring contacts insulated from each other, respectively extending from terminals, 42, to which the wires, 21, are connected. All the contacts, 38, are normally away from the contacts, 41, and, in pressing the key, the contacts are adapted to be closed just a little before the contact, 32, of the other end of the key touches the contact, 36. Thus the high-tension contacts are closed before the low-tension and opened after the opening of the low-tension contacts, which prevents sparking at the high-tension contacts.

The wire, 34, is connected with the primary coil of a transformer, 43, while the wire, 39, supported by an insulator, is connected to the secondary coil of the transformer. The shaft, 2, is also connected by a wire, 44, to the ground wire, 45, of the ordinary wireless outfit, while the usual helix, 46 (an oscillation transformer may also be used) and condenser, 47, are employed, the former being connected with an antenna in the usual manner.

Speaking of the apparatus, the inventor remarked: "This system is quite simple, and may be operated with any sending station using a transformer. Moreover, it can be constructed with any number of notes and of any size to suit the power of a particular station. I have a home-made working model playing thirteen notes on one rotor: do, mi, sol, la, si, do, re, mi, fa, sol, la, si, do."

Those who have heard it agree that it is real music. Chords are produced by pressing two or three keys, and if the feeding transformer can supply the necessary power we have surprising results and pleasant effects. Obviously a more elaborate machine constructed on the lines suggested would give even better effects.

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WIRELESS PROGRESS.

In the 2,000th number of the *Electrician* Dr. J. A. Fleming contributes in his usual lucid and interesting style a valuable article entitled "Radiotelegraphy: A Retrospect of Twenty Years." Dealing with the production of continuous waves —a subject of great interest to wireless men at the present time—Dr. Fleming says that a promising line of advance has been opened by improvements in high-frequency alternators. Starting from early work by Tesla and Elihu Thomson, R. A. Fessenden constructed high-frequency alternators of the Mordey type driven by De Leval steam turbines about the year 1907. In the same year R. Goldschmidt described a type of alternator in which by reactions between the fields of a stator and rotor each shunted by condensers and inductances frequency was multiplied up. Machines of this type have now been made up to 100 kw. in size, which can augment frequency from, say, 10,000 to 50,000.

E. F. W. Alexanderson, says Dr. Fleming, has, however, by careful attention to mechanical details, built improved inductor alternators giving frequencies up to 100,000 and output up to 50 kw., the necessary high speeds being obtained by step-up helical gearing running in oil. High-power stations for trans-Atlantic working have been constructed at Tuckerton, U.S.A., and Hanover, in Germany, in which Goldschmidt alternators are employed. These continuous wave generators necessitate special receivers. With the Poulsen arc a form of rotating chattering contact called a tikker is used. Goldschmidt has invented a tone wheel receiver which reduces the radio-frequency of received waves to an audio-frequency suitable for affecting a telephone. R. A. Fessenden devised a very ingenious method of beat-reception called a heterodyne receiver. The principle involved is that the high-frequency oscillations in the receiving antenna are made to create beats of frequency 300-500 by interference with a local service of high-frequency oscillations, and these beats can affect a telephone. The methods of undamped wave generation have rendered wireless telephony possible, and much interesting pioneer work has been done in this by Fessenden, Poulsen, Colin and Jeance, Vanni, Marconi and Round, and by Japanese workers. Speech has been transmitted 1,000 km. by radio methods by Vanni, and in one gigantic experiment conducted in the United States it was transmitted from Arlington, U.S.A., to the Eiffel Tower, Paris; and also to Honolulu. Radiotelephony is, however, still in the experimental stage, and has not yet been brought into a condition for commercial and regular use. Dr. Fleming concludes by saying that we are still looking for a more simple, cheap, easily managed yet powerful generator of undamped waves.

Wireless and Meteorology

A WIRELESS station has been established on Dickson Island, at the mouth of the Yenisei, by an expedition under the leadership of Dr. Kuchakov, for the purpose of sending meteorological telegrams to the physical observatory in Petrograd. The value of these telegrams will be felt chiefly in Siberia.

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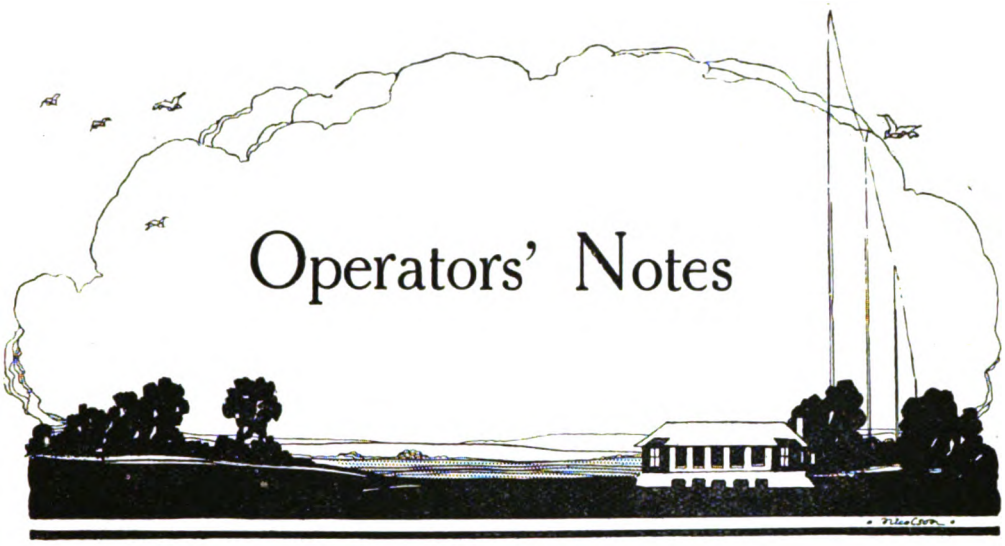

Faults on 1½ kilowatt set

By W. D. LACEY

CANDIDATES for the Postmaster's Certificate are required to demonstrate their practical knowledge of tracing and clearing faults.

The following notes have been penned with the object of aiding the student in this branch of the examination. The following is the order in which to attend to the various parts of the apparatus.

It is needless to mention that a thorough knowledge of diagrams is absolutely essential in tracing faults and connecting apparatus.

Main Switch.—See the fuses are in place, and that the switch blades are making proper contact in their sockets.

Motor Starter.—See the lead from the main switch is connected to the terminal marked *L*, and also note that the connection to the armature from the " A " terminal is joined. Next attend to the field connections. The no-volt release may be disconnected at one of the small terminals underneath it. The lead from the field terminal (marked *I*) should be connected to the field regulator, and the remaining terminal of the field regulator to the field connection of the motor. The return line from the motor joins direct to the main switch. The overload release on starter may be set in such a way as to short circuit the no-volt release, in which case the starter-handle will not adhere to the release. To remedy this, adjust the small brass scale until the pivoted armature is loose.

Field Regulator.—Attend to the connections mentioned above, and take care that the whole of the resistance is not in circuit, as this would cause the motor to gather too great a speed.

Motor.—Attend to *all* the brushes, see they make good contact with the commutator and slip rings. Note that the end of the field winding is connected to the return line, thus making a complete field circuit.

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After attending to the foregoing the motor may be started. The following are the indications of faults in the motor connections :

" Arcing flare upon release of starter handle denotes a disconnection in " the field circuit."

" Long thin spark at starter handle denotes disconnection in the armature " circuit."

" No sparking at all usually denotes a disconnection in both the field and " the armature circuits."

Guard Lamps.—If one or both lamps do not light when motor is running, examine the lamps, see the board is properly connected, replace the lamps, substituting new for faulty lamps.

Iolanda Switchboard.—Test both fuses with cell and galvo, see if pilot lamp glows (with motor running), if not, examine the lamp connections behind board, and see if lamp is burned out. If the A.C. guard lamp glows there is no reason why the pilot lamp should not, provided the above points are attended to. It is unlikely the mains between the slip rings and Iolanda board will be disconnected.

Low-Frequency Circuit.—From the bottom left-hand terminal of the Iolanda board a connection goes to the low-frequency iron core inductance, and from thence to the terminal of the manipulating key marked " MAIN."

The connections between the key and magnetic key are very easily attended to, all terminals being numbered, and each joins to its corresponding number. From the terminal of the magnetic key marked " TRANSFORMER," a connection goes to the transformer primary. The two primaries are connected in parallel by joining connections diagonally across the four outer terminals, thus :

From the opposite terminal of the transformer primary a connection returns direct to the bottom right-hand terminal of the Iolanda switchboard (as shown in sketch), thence through fuse, ammeter, and back to the main A.C. switch.

A.C. Voltmeter.—One terminal of the voltmeter is connected to the bottom right-hand terminal of Iolanda board, and the other is connected through a key to the transformer primary, as shown in the sketch, thus placing the voltmeter directly across the transformer primary.

Faults on Key and Magnetic Key.—Before attempting to get a spark (even when *all* circuits are connected correctly), the manipulating and magnetic keys should be searched for faults. When connected, as described under " Low-Frequency Circuit," the following faults may be found :

(1) The back contact of manipulating key may be screwed down, thus shorting the key.

(2) The armature of magnetic key may be screwed down at the adjusting pillar.

Both these faults would result in a continuous spark discharge upon closing A.C. main switch (with motor running).

(3) See there is sufficient tension on armature of magnetic key, as otherwise, upon making the first spark, the armature will stick down and make permanent contact with the bottom contact pillar, accompanied by flaring.

When properly adjusted the armature should vibrate to the changes of the applied alternating current.

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(4) Note that the bottom contact of magnetic key is not screwed back out of reach of the armature contact, as in this case the magnetic key is rendered useless for preventing sparking at the manipulating key.

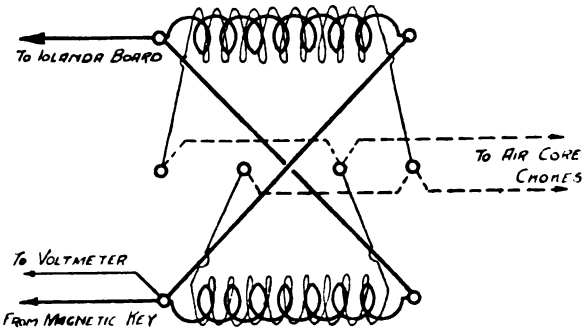
(5) Take care the side lever of manipulating key is not insulated.

High-Tension Leads.—The secondary windings of the transformer are connected in parallel (for 600 metres), as shown in sketch by dotted lines, and from the secondary terminals to the air-core chokes. The chokes can be tested by means of a cell and galvo, but it is unlikely anything will be found amiss with them.

From the chokes two leads go to the spark discharger, one to either terminal. It is highly important that all H.T. leads should be kept well clear of each other, and from low-tension conductors.

For 300-metre wave the transformer secondaries are connected in series. This is done by joining the two right-hand terminals of secondaries together, previously disconnecting the parallel connections.

If the secondary windings are short-circuited the motor will speed up upon depressing the manipulating key. A short circuit on the secondary may be caused by shorting the spark discharger or main transmitting condenser.



Closed Oscillatory Circuit.—All the connections of this circuit are made by heavy copper bus-bars, which are so made as to fit very closely together, and are insulated with wide strips of ebonite. If any of the bus-bars are removed it is an easy matter to replace, as its absence should be noticed immediately. Take care to observe the ebonite separators are in position, and that no points or edges are exposed to neighbouring bus-bars.

The spark gap (if of the fixed type) should be adjusted to 3 mm. (for 600-metre wave), and the condensers in parallel. The condensers are adjusted by means of a switch, which changes over the connections across the terminals.

Aerial Circuit.—One terminal of the jigger secondary is connected to the top plate of the earth-arrester gap, the opposite terminal of the jigger secondary connects to the aerial tuning inductance, or aerial direct (according to size of aerial). The tuning lamp should be connected between the earth terminal of jigger secondary and a point about four feet along the earth lead, usually the top plate of E.A. gap. It is not essential to transmission, and is only used to indicate when the aerial circuit is radiating maximum energy, and consequently is in resonance with the closed oscillatory circuit.

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The Emission of Electricity from Hot Bodies

By PROFESSOR O. W. RICHARDSON, F.R.S.

REVIEWED BY DR. J. A. FLEMING, F.R.S.

THIS book of 300 pages is one of the excellent series of Monographs on Physics edited by Sir J. J. Thomson and Professor F. Horton, in each of which the physical student finds some special department of physics treated by a writer who has made it a particular study. The subject of the emission of electricity from hot bodies has an especial interest for radiotelegraphists, because one of the well known and much used forms of wave detector is based on this phenomenon. Apart, however, from its technical application, the whole subject is of great physical, and indeed we may say cosmical, importance.

Professor Richardson has not included in his book any but the very briefest mention of the technical application of this thermionic emission, as it is now called. In his Preface he states expressly that he considered it undesirable so to do. No doubt he was wise not to enter upon the thorny path of discussion as to questions of priority in inventions. In fact, it is only since the publication of this book that an important legal judgment in the United States has cleared the air a little and given an authoritative decision on this matter of the technical application of thermionic facts in telegraphic apparatus. Neither does he discuss at all the problems in cosmical physics which are related to these thermionic phenomena.

The book is restricted to the consideration of the subject from a purely physical and modern research point of view.

It is divided into nine chapters, which are respectively headed: I. Mainly Considerations of a General Character; II. Theory of the Emission of Electrons from Hot Bodies; III. Temperature Variation of Electron Emission; IV. The Effect of Gases on the Emission of Electrons; V. Energetics of Electron Emission; VI. The Emission of Positive Ions by Hot Metals; VII. The Effect of Gases on the Liberation of Positive Ions by Hot Metals; VIII. The Emission of Ions by Heated Salts; and IX. Ionisation and Chemical Action. The author writes, therefore, for physicists who have some acquaintance with modern research, and does not expend any space on explanations of a popular character.

Moreover, owing to the wide expanse of knowledge on the subject, certain portions of it are excluded, such as the electrical properties of flames, which has already been treated in a monograph by Professor H. A. Wilson.

The chief topic of Professor Richardson's book is therefore the emission of electricity from hot bodies, generally in the form of an incandescent wire, in vacuo, or at least in rarefied air or other gases.

It has been known for nearly two centuries that the air near an incandescent solid body is a conductor of electricity, but an important contribution to knowledge was made by the late Professor Guthrie, in 1873, who showed that an insulated red-hot iron ball in air could retain a negative charge but could not retain a positive charge.

Matters are, however, complicated when we work in air or gases at ordinary

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pressure, and hence Elster and Geitel began about 1880 to examine the potential of the air in the neighbourhood of electrically heated wires in air of varying pressure up to so-called good vacua.

A discovery by Edison in 1884 formed the starting point for fresh research. Edison sealed into an incandescent lamp, made with his horseshoe-shaped bamboo filament, a platinum plate carried on a wire sealed through the glass; the plate being placed between the legs of the horseshoe. He found that when the filament was made incandescent by a continuous or direct current, a galvanometer connected in between the negative terminal of the filament and the terminal of the middle plate indicated little or no current, but when connected in between the positive terminal and the middle plate it indicated a current which might amount to one or two milliamperes.

Edison gave no explanation of this fact, nor did he make any application of it. Certain lamps made in this manner were given to the late Sir William Preece and he described experiments made with them in 1885 to the Royal Society, but neither did he carry the investigation to a point at which any sufficient explanation of the phenomenon was presented, though he made a number of new and interesting observations. The writer's attention had been drawn in 1882 to the phenomenon, subsequently called by him "molecular shadows," in incandescent lamps which indicated a radiation of matter in straight lines from certain overheated parts of the filament, and accordingly he examined more fully the Edison effect in researches described to the Royal Society in 1890 and to the Physical Society in 1896.

The general result of this work was to show that "the Edison effect" was closely connected with the radiation of matter of some kind from the incandescent filament. At that time electrons were unknown, for it was not until 1899 that Sir J. J. Thomson announced his epoch-making discoveries concerning masses smaller than atoms, which he called corpuscles, but which are now generally called electrons and regarded as units or ultimate elements of negative electricity.

In the writer's experiments it was shown that if the negative leg of the incandescent filament was included in a glass or metal tube, the Edison effect vanished, and several other experiments of like nature proved that the current which flows through the so-called vacuum was carried from the incandescent carbon to the middle plate by matter of some kind. The writer attributed this convection to negatively charged carbon atoms. Sir J. J. Thomson's classical experiments proved, however, that the negative electricity emanating from an incandescent carbon filament was carried by corpuscles having not more than about 1/1800 of the mass of a hydrogen atom. Hence it may be said that when a metallic wire or carbon filament is made incandescent in a high vacuum there is a continual evaporation or emanation of negative electricity from it in the form of electrons. The question, therefore, arises: What is the relation between the temperature of the wire and the number of electrons emitted per second per centimetre square of the surface of the wire? This is now called the thermionic current. Professor Richardson's researches have enabled him to give two formulæ, either of which is capable of approximately representing the facts, viz.

$$N = a\sqrt{T}\, e^{-b/T} \text{ and } N = cT^2 e^{-d/T}$$

where N is the number of electrons emitted per centimetre square per second, T is the absolute temperature and a, b, c, d are constants.

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The second formula has a rather better theoretical basis than the first.

The constants have been determined for various substances, and on page 69 Professor Richardson gives for carbon, $a=10^{34}$, $b=7{\cdot}8\times10^{4}$ and for platinum, $a=7{\cdot}5\times10^{25}$, $b=4{\cdot}93\times10^{4}$. It will thus be seen that the thermionic emission is greater for carbon than for platinum. The writer showed in a Royal Society Paper in 1890, that the "Edison effect" was very much greater for a carbon filament lamp than for one made with a platinum wire as the incandescing filament.

It has been shown, however, that when we heat a metallic wire up to about a dull red heat, the first effect consists in the production of positive ions round the wire, and these increase in number with the temperature. The negative ions do not make their appearance at first in great number, but they increase faster than the positive as the temperature rises.

The phenomenon is therefore much influenced by the nature of the gas in which the wire is immersed. Hydrogen seems to have a very marked effect in increasing the number of the negative ions. This part of the subject is treated in the fourth chapter of Professor Richardson's book, and it will be seen that there is some conflict of evidence as to the facts. It will be evident that we labour under great difficulty in not being able to exclude entirely the effect of the surrounding atmosphere. We are in the habit of speaking of "good vacua" or "high vacua" as if the spaces referred to were empty of matter. If we recall to mind that at atmospheric pressure there are in every centimetre cube about 10^{19} or 10^{20} molecules of air, it is easily seen that a so-called vacuum of one-millionth or even one-hundred millionth of an atmosphere is a space crowded with molecules.

It is, therefore, not remarkable that many experimentalists have come to the conclusion that the ions emitted by a wire, at least the positive ions, are the result of some ionisation of occluded gas. Professor Richardson has, however, shown in his interesting fourth chapter that there is no good reason to believe that the emission of negative electrons from metallic wires is due to chemical action between the metal and the occluded or surrounding gas. This electronic emission increases at an enormous rate with temperature, and in the case of a most refractory metal like tungsten with a melting point of about 3267° Centigrade, the emission may even amount to as much as 4 amperes per centimetre square. But a current of 1 ampere is 1 coulomb per second, and 1 coulomb is 3×10^{9} electrostatic units. Hence, 4 amperes is 12,000 million electrons per second.

The question then arises, Where do all these electrons come from?

According to one theory of electric conduction in conducting solids, there are within the solid free electrons which are moving irregularly like the molecules of a gas. The effect of an impressed E.M.F. is to superimpose on this indiscriminate electronic motion a regular drift in one direction. These free conduction electrons are in most cases about as numerous as the atoms of the metal, that is, there are about 10^{23} per c.c. According to this theory rise of temperature increases the velocity of motion of these electrons, and may therefore give some of them sufficient kinetic energy to carry them right out of the surface of the metal into the external region. There are some difficulties in the way of this hypothesis of permanently free electrons, but there is much to be said in favour of the view that the thermal

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electronic emission involves the same class of electrons as those involved in electric conduction. Generally speaking, the heating of the wire experimented upon is effected by means of an electric current. It is desirable that more extensive experiments should be made on the thermionic emission from substances which are heated, not electrically, but by radiant heat, as, for instance, by a powerful mirror or lens. Such experiments would have to be conducted in a tropical climate.

Returning then for a moment to the question of the emission of positive ions from a heated wire we find this part of the subject carefully treated in Professor Richardson's sixth chapter. The chief characteristic of this positive emission, as he points out, is its transitory character. This means that if a metal is heated at a constant temperature, not too high, the emission of positive ions falls off rapidly with time. The rate of decay increases rapidly with temperature. A wire which has lost the power of emitting positive ions through frequent heating can, however, have this quality restored by several methods which Professor Richardson describes, various experiments tending to elucidate the origin of these positive ions.

The eighth chapter of this book gives a long and interesting account of the emission of ions from heated salts. As is well known, Wehnelt discovered that certain oxides, such as those of calcium and barium, when heated in vacua on a platinum strip yield a very large electronic emission. The same thing occurs in the case of very many other salts. Curious to say, the function which connects temperature with thermionic current in the case of these salts is of the same mathematical form as in the case of metals and carbon. Nevertheless, the information collected on the subject raises more questions than it settles, and there is room for much work before the phenomena are fully understood.

The whole subject in fact is very closely connected up with that of chemical action generally, and hence it is quite appropriate that the last chapter of the book under review should be entitled "Ionisation and Chemical Action." There are many simple cases of chemical action in which the resulting compounds or substances exhibit electrification. Thus a rod of carbon burning in air acquires a negative charge whilst the air itself in the neighbourhood is positive. When iron is dissolved in sulphuric acid, the hydrogen liberated is positively charged. An enormous number of facts have been collected, but the general principles which can be traced in connection with them are so far few.

Before these more complicated effects can be explored it will be necessary to have more light upon the mechanism of simple thermionic emission from pure metals in the highest vacua.

The book before us, however, is a carefully collated record of much valuable research, and is, therefore, a very welcome addition to the literature of the subject.

Thermionic rectifiers and amplifiers have already proved themselves to be appliances of great value in connection with radiotelegraphy and radiotelephony, and any improvements to such appliances can only be brought about by a careful study of the physical phenomena involved. Towards this study Professor Richardson's book is a valuable contribution. The book is published by Messrs. Longman, Green & Co., and therefore it is needless to say that the printing and general appearance of the book are all that could be desired from the point of view of the reader and student.

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Wireless Telegraphy In the War

"Notes" in the Air.

"When found make a note of," says Captain Cuttle in Dickens's famous novel, *Dombey and Son*. We learn from wireless operators who ply their occupation at sea under present war conditions that the various notes which they are continually finding are almost infinite in their variety. A man on duty in the North Sea, for instance, after answering the deep note of the high-power station, as he is in course of adjusting his instrument, will often be quite dazed by the medley of notes which he is obliged to tune out before he hears the high, chirpy voice of his patrol leader. After breaking off from this he perhaps finds himself receiving the hoarse, rough note of a destroyer talking to the Admiralty. In quaint contrast comes later the piping tones of a paddle sweeper making his report to his superior ashore. By and by comes the clear small voice of a seaplane reporting "All is well," varied by a shrill but scratchy note, with a tone like that of tearing paper, which indicates that British submarines are out "nosing for the foe." Later on the flagship may call for attention with its dominating note, eloquent, by the very sound of it, of authority and importance. When a vessel is sinking, torpedoed by an enemy submarine, the ether is vibrant with notes, pitched in every imaginable key, and this continues until the matter is finally adjusted. So the day wears on to dark, when signals become louder and the operator listens eagerly for the Press News from Poldhu and Eiffel Tower, as well as for the fanciful tale radiated from Norddeich. Each of these stations is characterised by its own peculiar note.

Such is the epitome of a typical day's work carried through, all the time, by wireless operators at sea. We have summarised it from an account written *in extenso* recently by a correspondent of a Liverpool contemporary, since it does in fact, to our own first-hand knowledge, give a very fair outline of what wireless operating at sea is like in these strenuous days. Of a truth, the advice put by Dickens in the mouth of Captain Cuttle was conceived in a truly prophetic vein; wireless operators at sea are always finding fresh notes, and of "making notes" about them there often seems to be "no end."

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CO-ORDINATION AND WIRELESS LINKS.

A most noteworthy feature in the present Grand Offensive of the Allied Forces consists of the immensely improved co-ordination of the various branches of military activity. The enemy himself has expressed admiration for the way in which the French infantry, artillery and air-craft work in unison ; whilst, to judge from recent results, the same *desideratum* appears to be more and more realised in the case of our own gallant Army, whose initial difficulties—owing to their more recent organisation—were far greater in this respect. Interwoven with all of them are the wireless sections, which form the connecting links, and enable the observation officers to guide the operations of the whole offensive. Our illustration on this page will (taken in conjunction with those printed in former issues) enable readers to follow in detail the items which go to make up this effective whole. Mobile wireless stations follow the airmen and infantry as they move from one place to another, and are not liable to the interruptions caused by enemy artillery through the severance of wires essential to the old form of field telegraphs. The illustration overpage will specially arrest attention, as it depicts a French field wireless installation on the Somme in the act of transmitting a message to Headquarters.

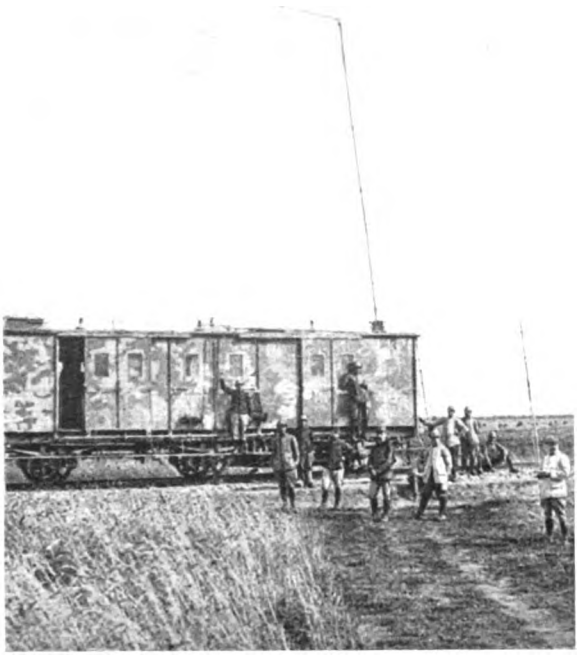

Photo by [*Newspaper Illustrations,*

FRENCH WIRELESS RAILWAY INSTALLATION.

An excellent example of the importance of maintaining continuous "touch" between Divisional Headquarters and the front lines was recently furnished by the despatch of the German General von Armin. He lamented the deficiencies in this respect under which the Germans on the Somme were suffering, and pressed urgently for the issuing to the Staffs of infantry regiments and battalions of an increased number of light wireless stations. Moreover, on the Austro-Italian front we have been recently treated in one of our Allies' *communiqués* to a description of the "drum fire" inflicted by the Italian long-range guns. These concentrate a heavy bombardment upon areas far behind the line of battle with the express object of severing the enemy's telephone and telegraph wires. Austrian *communiqués* recently admitted the success of their adversaries in this respect, but claim that "connections were not altogether dislocated." Such incidents as these constitute an eloquent commentary on the growing superiority of the Allies.

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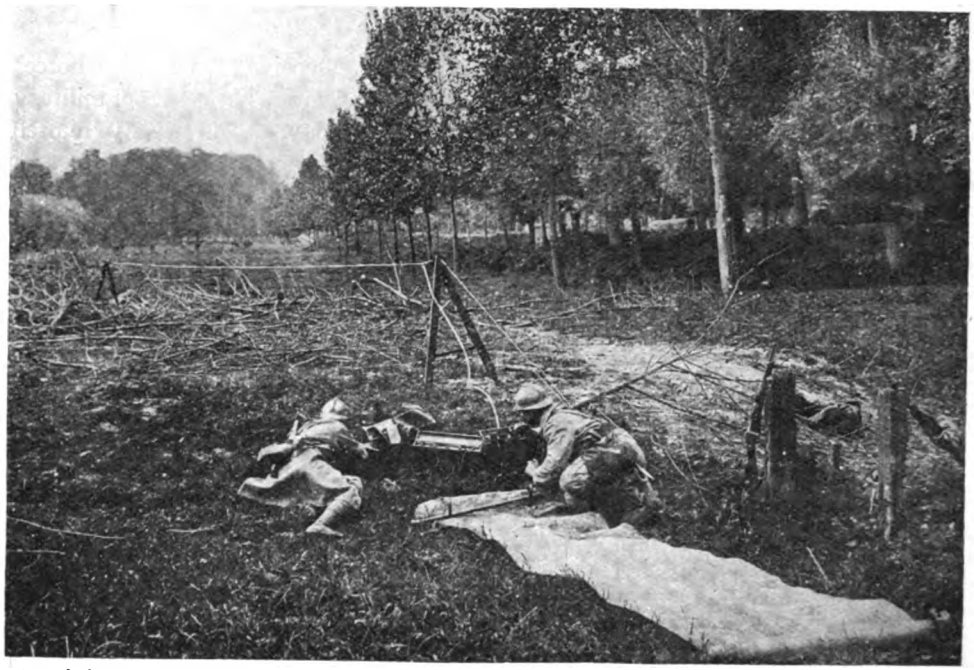

Photo by [*Newspaper Illustrations.*

(*c*) FRENCH WIRELESS OUTPOST ON THE SOMME.

A Famous British Journalist.

Nothing strikes the imagination so much as the unexpected. Queen Victoria's favourite statesman, Lord Beaconsfield, was well aware of the fact, and made such use of his knowledge as to earn from the satirists of his day the soubriquet of "Our "Startling Man." Lord Northcliffe belongs to the same intellectual order as Benjamin Disraeli, and as soon as he had extracted all the pungent "copy" available out of Verdun, he turned his attention to astonishing the public by his revelations of the success of Hun propaganda in Spain. From the little fortified city of Pampeluna, in the northern section of the Iberian Peninsula, he addressed a series of articles to the *Times*, giving full details of the way in which the Germans utilise their practised skill in "wireless" (and other) propaganda work to capture public opinion there. "Their chief methods seem to be," says Lord Northcliffe, "the transmission of a "daily stream of wireless *communiqués* from Berlin and Austria discrediting the "Allies, continuous activity on the part of the Church and Carlists, and the influence "of the German colony, together with steady work on the part of the University "professors and skilled masters on behalf of the Central Powers—the chief channel "being, of course, the Press." This process has been going on ever since the war started, and, despite the disadvantages under which the Teutonic mind must work when in contact with so totally dissimilar a point of view as that of a Latin race, they seem to have succeeded to such an extent that "one is doubtful of the lasting "effect of anything short of a smash and palpable military defeat of Germany, one "that cannot be disproved by wireless."

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U-Boat "Heroes" in Spain.

It will be remembered that this last summer Cartagena was honoured with a sensational visit from the German submarine U 35. We are now able here to reproduce two pictures taken on that occasion: (*a*) Showing the German under-water craft entering the harbour in the early morning, and (*b*) a part of the same submarine lying alongside the Spanish cruiser *Cataluña*.

Photo.] [*W. B. Cole.*

U 35 ENTERING CARTAGENA HARBOUR.

The Wireless Aerials are of "Inverted L" type.

A correspondent informs us that the U 35 was plainly expected, for the numerous members of the German colony were all waiting for her. Indeed, Germanophil news is so prompt in reaching the Peninsula, despite its total isolation by land from the Central Powers, that there is every reason to believe that the Spanish authorities, with the best will in the world towards maintaining the etiquette of neutrality, are not able to prevent the use of illicit Teutonic wireless. The whole U-boat affair was conducted in the most theatrical manner; the German officers paraded the city at all hours, acknowledging salutes in an extravagantly dramatic manner. Gaping crowds followed them all over the place, and watched the "Cabelleros" take their refreshment in the open-air cafés.

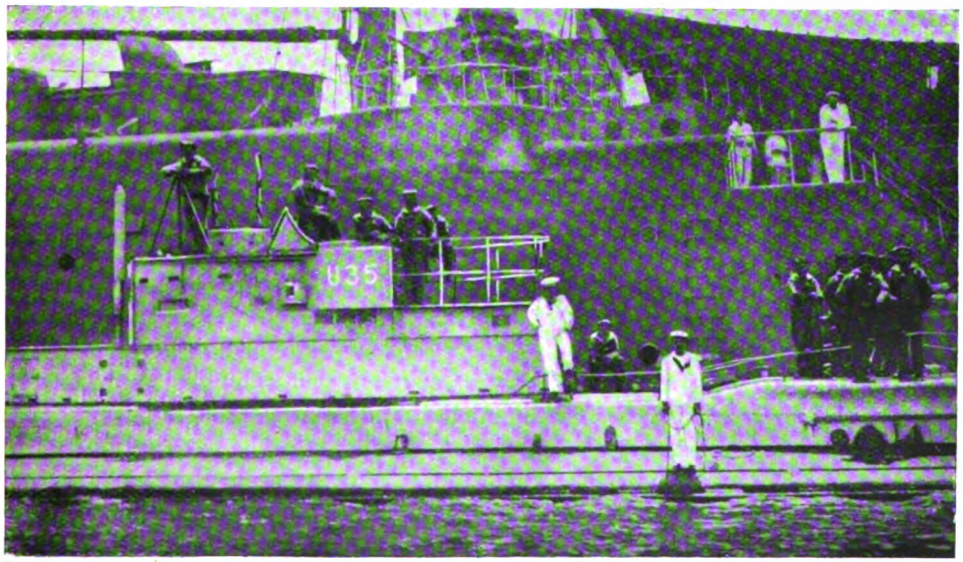

Photo by] [*W. B. Cole.*

GERMAN SUBMARINE ALONGSIDE SPANISH CRUISER "CATALUÑA."

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War Notes

A Sailor's Chivalry.

A VERY touching little posthumous incident connected with Captain Fryatt, the gallant Commander of the *Brussels*, so infamously done to death by the Germans, was recently chronicled by the daily Press. The English stewardesses who, after a great deal of diplomatic *pourparlers*, were at length released in the beginning of October, narrated that Captain Fryatt was warned by the Germans that if he employed his wireless equipment his vessel and all on board would be sent to the bottom. Therefore when the wireless operator asked, as the Germans clambered on board, whether he should summon aid the chivalrous seaman answered, " No, I don't care " what they do with me, but I must think of the lives of the women I carry." In view of the recent haul of German and Dutch spies made by the Netherlands Government, the further statement of the stewardesses that movements of the *Brussels* were signalled by flashlight to a German submarine lurking in Dutch waters, and retransmitted by wireless to the German torpedo boat, assumes an air of verisimilitude.

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Zeppelin Scouts.

The Norwegian newspapers often contain very illuminating little notes concerning the procedure adopted by the enemy. We recently observed a statement, made in the *Tidens Tegn* of Christiania, to the effect that our enemies are taking advantage of the longer range of the more powerful wireless apparatus carried by the latest type of Zeppelin. This wider range enables the German Admiralty to dispense with any other North Sea patrols beyond their airships, which " are watching day and night " all commercial steamers passing to and fro, and communicate the intelligence they " gather by wireless to their submarines."

* * * * * *

Aeroplane Equipment.

We learn from the representative of the Advisory Committee for Aeronautics, presided over by Lord Rayleigh, that many improvements in the detail of aircraft equipment have recently been made. Included in the list of developments recorded by the Committee is the provision of fresh designs of wireless sets of a very light weight for use on aeroplanes. These have been duly decided, and satisfactory results obtained.

* * * * * *

Afraid of Wireless.

It would appear that a neutral observer was recently visiting Belgium on behalf of the *Matin*. Amongst other interesting items of information brought back by him is the statement that the Germans continue to be extremely nervous with regard to wireless telegraphy, and maintain a ceaseless search with a view to discovering signs of its employment. Indeed, they have recently carried out a campaign of prosecutions and imprisonment throughout Belgium.

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Re-arming Disabled Soldiers for the Battle of Life

How the Mayor of Lyons re-fits Men Maimed in the Present War for their Return to the Ranks of Industry

A GROUP of men were once gathered together watching a sight which stirred the emotions of them all. Various expressions of feeling came from different spectators, and one of them, a Quaker, thus brought matters to a head. "Friend,"

[*Cliché de l'École de Tourvielle.*

TEACHING WIRELESS TELEGRAPHY AT THE LYONS SCHOOL.

said he, addressing one of those who had given freest play to his expressions of pity, "I sympathise £10; how much is thy sympathy worth?"

The moral of this apologue is that sentiment loses its value unless every endeavour be made to translate it into practical activity. Sympathy for war-sufferers abounds in England; but are we as practical in our expression of it as our gallant Allies across the Channel? The following account of their good works may give us "furiously to think" in this respect.

There probably never was a war which will leave so large a legacy behind it of men whose industrial activity might at first sight appear to be ended for ever. If this were *actually* the case to the extent to which it is *apparently* so, an enormous

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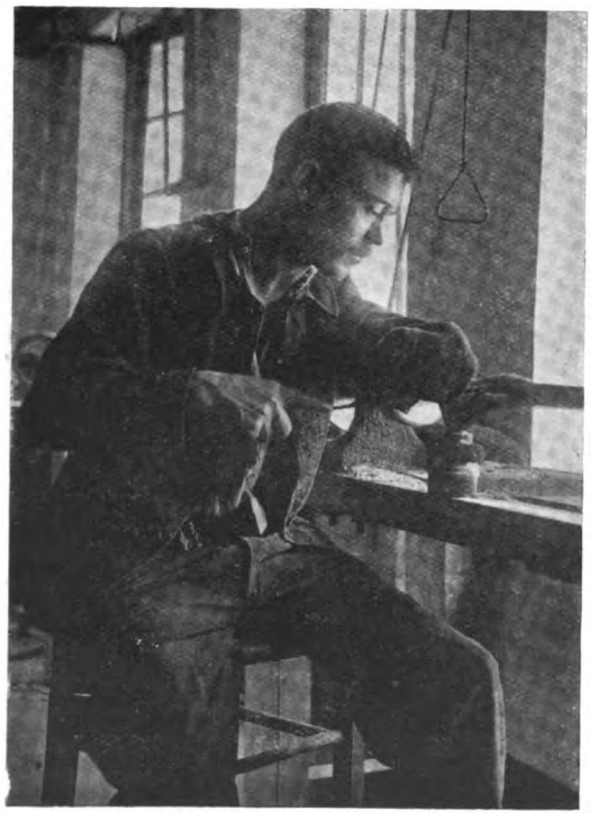
amount of misery would result for the victims themselves, and a vast economic loss to the community at large. Philanthropic sympathy for the individual and patriotic zeal for the community therefore combine to impress us with the desire to bring this incapacitation within as narrow limits as possible. A most notable effort in this direction is due to the far-sighted initiative of Mons. Herriot, the public-spirited *Maire* of Lyons, who, from the moment when the stream of wounded started flowing in during the autumn of 1914, realised the extreme desirability of taking action at once, and refused to postpone his efforts until the end of the war. The Lyons Industrial Schools for the wounded are the result of his action. By their establishment—like the Quaker above referred to—this noble Frenchman has translated his sympathy into terms of active assistance.

Wounded men, especially those with amputated limbs, are usually unable to follow the occupation by which they earned their bread in times of peace. Mons. Herriot realised that they must, therefore, be trained afresh, and proceeded to establish an organisation for so doing. He was confronted with two alternatives :

(*a*) He could follow the principle of the Day School, allowing the pupils to make separate arrangements for board and lodging ; or

(*b*) He could proceed on the lines of the Boarding School, taking charge of their whole existence, and not merely of those hours devoted to training and study.



[*Cliché Meurisse.*

A ONE-ARMED PUPIL STUDYING CARPENTRY AND WOOD TURNERY.

In view of the peculiar circumstances of the case, his choice fell upon the latter, and he has set up establishments in which wounded soldiers who have been finally discharged from hospital can, after but one week's furlough, be received and trained completely, free from any distracting influences incidental to their being partially out of the control of their School of Administration.

It was on November 30th, 1914, that Mons. Herriot induced the Municipal Council of Lyons to authorise the establishment of such a school in his town. The Minister for War granted

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[*Cliché de l'école de Tourvielle.*
ONE-LEGGED TAILORING PUPILS.

the necessary confirmatory authorisation on December 29th; but so rapid was the action taken that pupils had already started coming in on the 16th of the same month. The principle upon which students are chosen is that only those should be accepted who are completely and definitely cured, *i.e.*, that they should belong to the class which is known in France as men entitled to discharge No. 1. The greater number are those who have been incapacitated through amputation, although some of the pupils suffer from paralysis or cramp. As soon as the candidate is discharged from hospital, the School Authorities first of all make sure that he is capable of standing the strain of labour and he is subjected to a careful course of interrogation, conducted with the utmost kindliness and tact, in order to ascertain not merely the occupation which he followed before the war, but also his personal habits and constitution. Over and above this, the interrogator endeavours to ascertain the general tendency of his moral attitude and character. The object of this latter procedure is to make sure that he possesses the necessary will-power for profiting by the opportunities which the school affords. Even after these preliminary tests, great care is necessary before the candidate is started upon the course destined to fit him for the battle of life. Once started along particularised lines no deviation is possible, and it is therefore of the utmost importance that mature consideration should be given before the individual selects his future occupation. This fact is realised and acted on by the School Authorities.

The good work has been located in two different buildings, one in the centre of the town known as the École Joffre (41 rue Rachais), the other in a suburb of Lyons, which is entitled the École de Tourvielle. The former is the original establishment and the centre of administration. Pupils are boarded, lodged and instructed free, and existence is made as agreeable as possible to them by an extremely paternal supervision. They remain as long as is necessary for acquiring a knowledge of the trade selected, and in fact pass through so complete an apprenticeship as to be assured of finding work under advantageous and remunerative circumstances as soon as they are ready to leave the establishment. Moreover, Mons. Herriot

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has decided to allow a small daily wage of 1 franc 25 cents, which the students can either allocate to family needs or put by in order to constitute a little hoard which may be useful to him in settling down to outside life.

For the convenience of those who desire to find employment straight away without passing through any school curriculum, an Employment Bureau has been established, which keeps in constant touch with private firms and public bodies likely to have suitable places to offer. Experience up to the present has shown that, in the case of these Employment Bureaux, the demand for workers considerably exceeds the supply.

The first class to be constituted was that of Dactylography ; and, apropos of this, Mons. Herriot remarks that he has been extremely surprised by the rapidity with which men who have lost their right arm acquire the art of writing with the left hand. The other subjects for which facilities for study have been provided are as follows :—In the École Joffre, 41 rue Rachais, pupils receive instruction in accountancy and toy making, besides education in the art of book stitching and binding ; at the École de Tourvielle (situated in a suburb of Lyons) the curriculum comprises boot-making, tailoring, carpentering, horticulture, clog-making and Radio-Telegraphy. *Instruction in Wireless Telegraphy* was initiated in November, 1915, under the management of Commandant Peri, the head of the Military Wireless Station at Lyons. Two special teachers have been appointed, and, at the moment of writing, there are 30 pupils in training there. Besides technical instruction and courses in the theory

[*Cliché Meurisse.*

TOYS MADE BY PUPILS AT THE LYONS SCHOOL.

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of the science, general education forms part of the course, so that pupils receive tuition in Geography, Modern Languages, Orthography, etc. Some special courses in Electricity are, moreover, given to them by a Professor of the *Faculté des Sciences.* Up to the present, thoroughly satisfactory results have been obtained, and already some of the pupils have taken up duties in good Wireless Stations. A short while ago one of them received an appointment as Wireless Telegraphist in Konakri, French New Guinea.

In our illustrations we show (*a*) the Wireless School, (*b*) a one-armed pupil at the Carpenter's Bench, (*c*) a group of one-legged tailors, and (*d*) a group of toys manufactured by students. France in pre-war days shared with England the anomalous position of finding the pushful Teuton ousting her own sons from enjoying the fruits of labour in their own country. A notable result of the present war will be (at all events, we all hope so) to sweep away these disgraceful anomalies. The toy-making industry in particular had been practically monopolised both here and on the other side of the Channel, and no better object-lesson can be afforded to English and French children than these toys manufactured by France's maimed soldiers. Illustrations of these are shown on page 618. They will therefore afford British and French little ones not only the intrinsic delight they possess in themselves, but the extrinsic interest of being symbols testifying to the reawakening of national spirit, a reawakening all the more precious for having been accomplished through suffering.

We are sure that readers of THE WIRELESS WORLD will appreciate the noble work undertaken by this patriotic *Maire* of Lyons and his coadjutors, especially in view of the fact that, thanks to their exertions, men who would otherwise have been derelicts from this great world-struggle have been enabled to take an active part in the work of Radio-Telegraphy, despite all the ravages that war has been able to work upon their bodies. The schools are carried on, moreover, without calling upon State or Municipal aid, being *entirely supported by private benevolence.* The present writer recently received a communication written by this distinguished Frenchman with his own hand, and cannot close this brief summary better than by quoting from it. Mons. Herriot states that :—

" I have as yet none but French soldiers, but I should be delighted to receive " here the brave wounded warriors of Great Britain. Such comradeship might " produce extremely happy results. My schools being entirely supported by private " generosity, I should moreover welcome any material aid which any of my English " friends might find it possible to give. For the rest I would be responsible. The " sons of Great Britain would be received and welcomed in our French Home with " a warmth equal to that with which we cherish our own children."

The spirit of humanity and patriotism which finds expression in these words constitutes an object lesson for us all. Not least notable is the fraternal feeling towards Great Britain which breathes through this letter. We welcome the " Brotherly Love " of the civic chief of this historical French city, and share in his remarkable enthusiasm for closer union and co-operation from this side in the work he has so much at heart.

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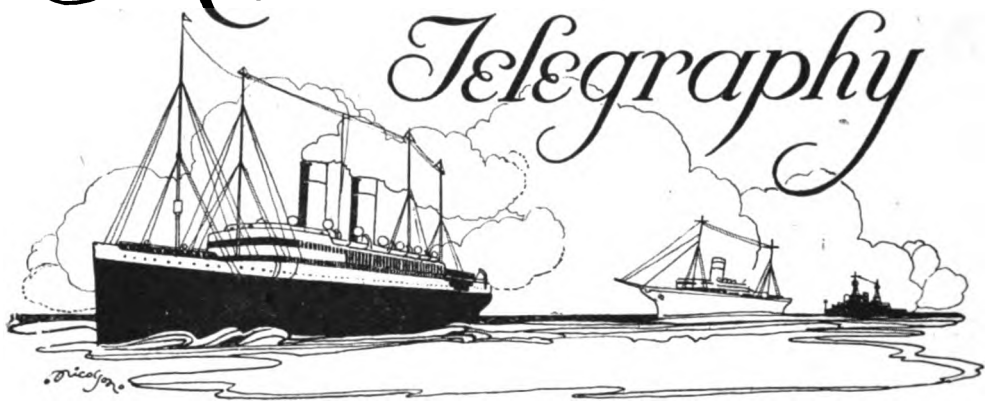
Maritime Wireless Telegraphy



New United States Motor Petrol Cruiser.

The Naval Department of America has recently prepared specifications for two motor patrol boats. The larger of the two was to cost 28,000 dollars, and have a speed of at least thirty miles an hour. Provision was to be made also for a full load of fuel, stores and munitions, the necessary crew and a 3-pounder gun. The boat is of the hollow-bottom, wave collecting type. She is 66 feet overall, 13¼ feet beam and 4½ feet draught. A wireless room, about 4 feet square, is included in the design, and the ship will be fitted with wireless telegraph apparatus. The American Naval Authorities consider the ship eminently suitable for patrol service and the chase of submarines.

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Canadian Ice-Breaking Steamer.

On May 15th last the ice-breaking steamship *J. D. Hazen*, built for the Dominion Government, was launched at Montreal. The christening ceremony was performed by Lady Borden, wife of the Canadian Prime Minister, and the whole proceedings were crowned with success. The *Canadian Railway and Marine World* gives the following particulars: The vessel which is intended for work on the St. Lawrence river, possesses a length over all of 292 feet, a moulded breadth of 57½ feet, a moulded depth of 32 feet, and a draught of 19¼ feet. She is of the twin-screw type, designed to work through the ordinary sea ice formed in the river from 12 to 30 inches thick, and also pack ice which accumulates in certain parts of the river, particularly at Cape Rouge. She is of very massive construction, necessitated by the nature of the work she will perform, and, as might be supposed, is fitted with a complete wireless telegraphic apparatus and a searchlight of 25,000 candle power. Electric current is supplied by two direct current compound dynamos driven by high-speed enclosed compound engines.

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Gale Sinks American Ship.

How the *s.s. Ramos* went down is fully and interestingly told by Mr. Ray Green, a wireless operator, in the September number of our contemporary, *The Wireless*

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Age. The ship was on a trip from Philadelphia to Cartagena, Colombia, but on the way out she ran into very dirty water, huge seas rising and breaking with tremendous force on the ship's forecastle. Matters got to such a pitch that the captain instructed the operator to send out the SOS signal. Although he could hear Miami station working, for some reason or other he was not able to get in touch with it, and it was only after another steamer had picked up his message and broadcasted it that Miami replied to his call. The result was that two or three vessels, who were within 100 to 150 miles of the distressed steamer, wirelessed that they were proceeding to her aid with all haste. Troublous times were, however, ahead for the crew of the *Ramos*. She was sinking quickly, and the captain ordered the men to the boats. Whilst Mr. Green and some others were sitting in a lifeboat which was being lowered, the *Ramos* rolled to such an extent that men and boat were precipitated into the sea. They subsequently managed, however, to get back into the boat, which was very fortunate as they were within a shark-infested area. After keeping the boat's head to the wind for many hours, they subsequently sighted a vessel which took them aboard and eventually brought them safely to land. It was not an experience which any of them would wish to undergo a second time.

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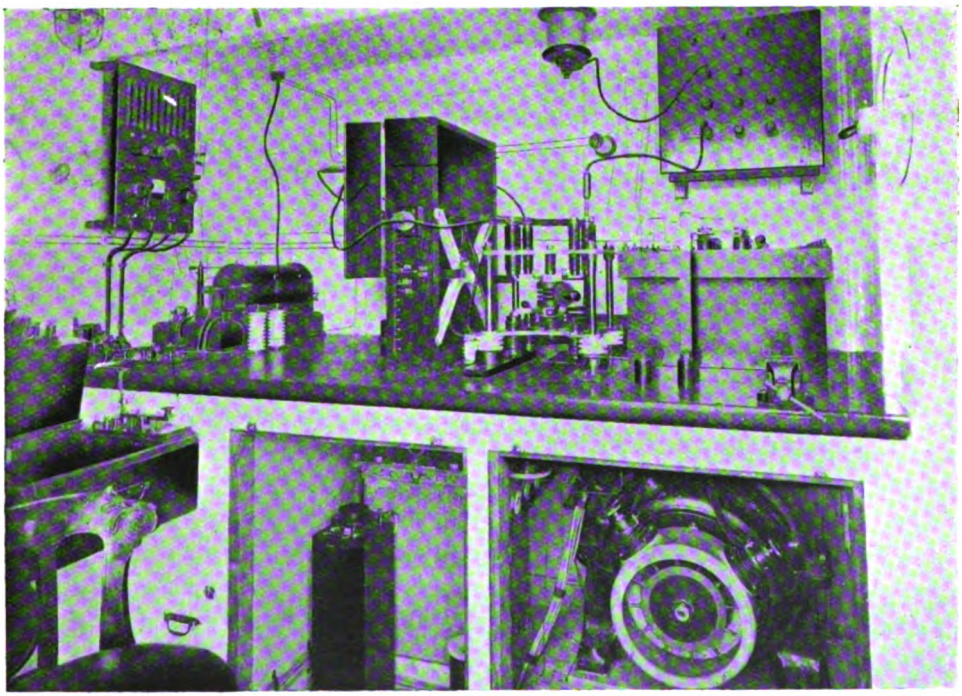
FOOD FOR HUNGRY ANIMALS.

Another curious incident of the application of wireless telegraphy to the needs of the moment is apparent in the following: A ship bringing wild animals from



3 K.W. TRANSMITTING APPARATUS ON BOARD THE SPANISH GUNBOAT "BONIFAZ."

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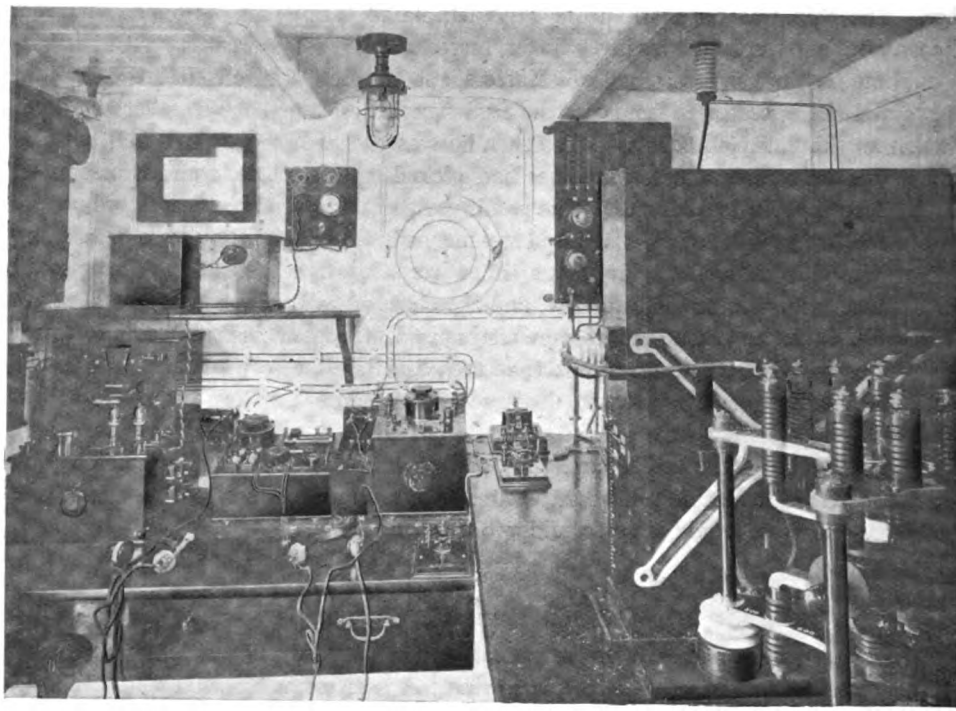

RECEIVING APPARATUS ON BOARD THE SPANISH GUNBOAT "BONIFAZ."

London to Brooklyn, U.S.A., found herself towards the end of the voyage with an insufficient quantity of food for them. Matters were getting serious, as owing to the lack of nourishment the beasts commenced to attack each other. The captain, therefore, sent a wireless message asking for food to be sent to the ship, and a fast tug was laden with meat and despatched to meet the vessel.

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WRECK OF THE "MATATUA."

The 6,000 tons steamer *Matatua* was in distress off Cape Race, Newfoundland, and was compelled to send a wireless message asking for aid. It was during a very wild gale and the worst fog of the season that the liner *Stephano* was making her way when she received the *Matatua's* call. Although the *Stephano* herself was so close to the rocky cliffs of the land, she immediately started searching about for the distressed steamer. The *Matatua* was, however, beyond help, as she was firmly aground. Her passengers had fortunately been able to get to land.

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SURGEON CALLED BY WIRELESS.

Whilst the steamer *Centralia* was transferring cargo in the harbour at Mazatlan, one of the crew was hit by a sling load of freight and knocked into the hold, sustaining a broken left arm and a serious fracture of the ankle. The operator of the ship immediately called the United States gunboat *Annapolis*, which was lying at anchor a short distance away, and obtained surgical aid within a very few minutes.

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NOTES OF THE MONTH

ONE of the consequences of the *Titanic* disaster in 1912 was an arrangement made between the British and United States Governments for providing ice-patrol vessels on the North Atlantic route to give wireless warnings of the presence of icebergs. Under arrangement with the British Government the U.S.A. have been performing this service single-handed since the outbreak of war, and the Washington authorities send regularly to London reports on the operations of the patrol vessels. The latest of these reports deals with the period from February to the end of August, and it is interesting to note that one of the largest icebergs encountered was located only forty miles north of the steamship lines in the earlier part of June. This natural phenomenon was so huge that the U.S.A. patrol ship *Seneca* found it necessary to stand by for eight days radiating wireless warnings, which caused the deviation of many steamships from the route taken by the iceberg, whose pinnacles when first found were more than 200 ft. in height, whilst the whole mass measured about 400 yards long.

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On pages 615 to 619 of this issue we publish an article dealing with the way in which France handles the problem of the disabled soldier, and we have recently had our attention called to efforts on somewhat similar lines which are being made in Canada and at Tipperary. Readers of THE WIRELESS WORLD will note that a certain number of the maimed patients of the French Schools are being instructed in wireless telegraphy. It gives us the greatest pleasure to realise that it is possible for men, maimed whilst fighting for the cause of humanity, to so far overcome their disabilities as to become expert telegraphists. There is every reason for affording such men suitable opportunities for employment, but it is perhaps not inadvisable to remind both trainers and pupils that *for service at sea full physical fitness is absolutely essential.* The conditions under which they have to work at sea may make at any time the fullest demands upon the physique of wireless operators, so that it would be a mistaken policy to expect this sound regulation to be modified even in favour of our war-disabled heroes.

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On pages 460 and 461 in our September issue we printed the text of the new Government Regulation imposing compulsory wireless upon all steamers over 3,000 gross tons. Action is already being taken under this new regulation, and the vessels belonging to this category are being granted the necessary licences (which involve the obligation of wireless installations) as rapidly as the supply of apparatus, etc., permits.

It is interesting to note in this connection that about the middle of September the French Mercantile Marine Committee appointed nine Commissioners, who, in conjunction with the delegates of Naval and War Committees, will consider measures

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for ensuring the security of French mercantile vessels by the installation of wireless telegraph apparatus, their equipment with armament and the laying down of regulations for navigation.

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We would call the attention of WIRELESS WORLD readers to the appeal recently issued in the Public Press by Lady Marconi on behalf of the Italian Red Cross in London. She points out that the recent extremely heavy fighting on the Northern Italian front has caused a great influx of wounded men, and imposed a very severe strain upon the funds of the Society. The advent of winter weather with its consequent demand for warm woollen clothing (of which there is great scarcity in Italy) still further increases the drain upon the financial resources of this noble institution. Lady Marconi refers any who may desire further details to the Italian Red Cross, 14 Weymouth Street, Portland Place, London, W., and asks that all who can see their way to demonstrate their sympathy with our Italian Allies in a practical manner, may remit donations to that address.

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Among the relics of the wrecked Zeppelins now being exhibited in London we find portions of wireless apparatus. Wireless telegraphy has been very useful to the Huns in their airship raids on England, for by it the gasbags have been able to keep in touch with one another and with Germany. Writing on wireless on Zeppelins reminds us that in the window of an Oxford Street showroom there hangs a model of a British "Zeppelin" on which the wireless aerials are fitted in rather a peculiar manner. Instead of the usual trailing wire suspended from the centre of the airship, antennæ of the conventional ship type run parallel with the sides of the balloon. It is not stated whether this is the model of a real airship or merely an advertising novelty.

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The Manchester School of Technology is to continue during the winter its war-research work on behalf of the Government, and the scientific training of fit men for army commissions. The course in the first year will be specially to prepare the students for accepting commissions, and will include training in mechanics, methods of calculating ranges, explosives, mining, sanitation, water, searchlights, telephones, wireless, poison gas, field sketching, and gunnery. Truly a comprehensive list!

* * * * * *

Commencing from October 27th, Dr. J. A. Fleming, the well-known scientist, is giving a course of six lectures on "Long-Distance Telephones." The lectures will take place at University College at 5 p.m. on Friday. The sixth lecture will be of particular interest to our readers, as it deals with radiotelephony, its methods, and achievements. The course is open both to members and non-members of the University, and the fee is £1 11s. 6d. Application for tickets of admission should be made to the Secretary, University College, Gower Street, W.C.

* * * * * *

At King's College the new term began on Wednesday, October 4th. The Faculty of Engineering have arranged a course of study, extending over three or four years, in civil, mechanical, and electrical engineering for the engineering degrees of the University of London, and for the diploma and certificate of the College. Provision is made at the college for research work in wireless telegraphy.

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Naval and Military Wireless Telegraphists

Their Status and Conditions of Training

* PART II.

Radio-Telegraphists in the Army.

Wireless telegraphy constitutes an important branch of the Army Signal Service, and the officers, non-commissioned officers and men of this branch, as in the rest of the Signal Service, all form part of the Royal Engineers.† The technical personnel of the Wireless Section R.E. may in the main be classified under the following three headings :

(*a*) Wireless operators.
(*b*) Wireless electricians and instrument repairers.
(*c*) Wireless fitters and engine-drivers.

The names of the two former classes are self-explanatory, while the men of the third class are responsible for the care and repair of the petrol engines which furnish the power for the larger types of portable Army wireless station. Men who are accepted for service in this trade should have a thorough knowledge of petrol engines and be used to carrying out small repairs. A certain number of good engine fitters without special knowledge of petrol engines can also be employed.

[*Photo : Gale & Polden.*
A SAPPER (ROYAL ENGINEERS)

Wireless telegraphy in the Army has a very wide scope, and it has been successfully made use of in the present war on all fronts. Mobile stations may have motor or horse transport, or may be carried by the men who operate them themselves. A knowledge of petrol engines is therefore useful to operators, electricians and other tradesmen as well as to the fitters and engine-drivers themselves, while familiarity with horses and ability to ride across country are invaluable qualifications, since at least a fifth of the wireless personnel in the field is likely to be used at one time or another with horsed sections. To suitable men who are not able to ride on enlistment this accomplishment is taught while they are undergoing their preliminary training at home.

No man is enlisted specifically for wireless service in the Army unless he is already in possession of specialised knowledge. The majority of the recruits taken

* The first part of this article appeared in our October issue.

† For the separate organisation of the Royal Flying Corps and particulars thereof, see final section of this article.

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have already some acquaintance with either radio-telegraphy, ordinary telegraphy, electrical science, dynamo engineering, fitting or lorry driving.

Recruits wishing to be trained as wireless operators have to pass the ordinary Army medical examination and physical tests, and then, if they are approved for service in the wireless section, are drafted to a school or training centre, and are put through an initial course of instruction.

PILOT'S BADGE OF THE R.F.C.

This course covers both practice and theory, and an additional attraction to intelligent men who are anxious to make their way in the world is afforded by the fact that while serving their country they are learning a new trade with constantly increasing scope, and are thus gaining highly specialised knowledge which may be very useful to them in later life.

The practical side of the course is, at this initial stage, confined to operating, and beginners are taught to send and receive in plain language up to 20 to 25 words, and in code at 15 words per minute. Special practice is given in the reception of weak signals and the formation of block letters.

The theoretical side includes the first elements of electricity and magnetism, including electrostatics and dynamics, and the function and properties of conductors, insulators, condensers, primary and secondary cells, etc. This elementary grounding is followed by instruction in the principles underlying wave motion, the functions and properties of the various forms of oscillating circuits, and the simpler types of sending and receiving circuits. The construction and utilisation of the apparatus employed in actual working in the detectors, and other portions of the wireless stations are dealt with at length and demonstration is carried on side by side with the lectures, the students being given every opportunity of handling and working with the various types of apparatus.

This course may be taken either at the Army Wireless Training Centre or at an approved outside school, and when he has finally satisfied the authorities of his proficiency in the subjects laid down, the recruit, who up to this time is drawing Army pay at the rate of 1s. 2d. per day, now commences to draw Engineer pay as a technically trained soldier at the rate of 6d. per day in addition. Further instruction on the Army wireless sets and in the duties of a soldier leads to further tests, and if these are satisfactorily passed, the Pioneer becomes a fully fledged Sapper and draws Engineer pay at 1s. per day in addition to his Army pay.

From this stage of his career increase of pay may come either through increased technical proficiency with a rise to the "Skilled," "Superior," or "Very Superior" rating of Engineer pay (respectively 1s. 4d.,

BADGE OF OBSERVATION OFFICER, ROYAL FLYING CORPS.

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1s. 8d., 2s. per day), or by efficiency as a soldier leading to rise to N.C.O. or even Warrant Rank, with consequent increase of Army pay from 1s. 6d. as a lance-corporal to 3s. 3d. as a sergeant, and so on, while N.C.O.'s also draw Engineer pay according to their technical abilities.

The final stage in the promotion of a thoroughly efficient man is to the commissioned ranks of the Army. Such appointments will, as a rule, be made by selection from non-commissioned officers who, in the opinion of their Commanding Officer, are qualified both technically and in a general sense to be nominated as cadets and put through a special course at the training centre.

With regard to BADGES, there are not (as in the Navy) authorised distinguishing badges for the wireless men of the Royal Engineers, they merely wear the insignia of their Army rank in the ordinary way. Any special distinguishing marks that may be worn are adopted on the authority of the Commanding Officer.

Radio-Telegraphists in the Flying Services.

In the case of the Air Services we find two divisions :

(*a*) The Naval Flying Corps, and

(*b*) The Army Flying Corps.

The latter is officially known as the " Royal Flying Corps." In both cases they really constitute separate branches and require separate treatment.

Naval Air Service Operators.—Wireless operators for the Royal Naval Air Service are recruited from two sources :

(1) Boys between the ages of 17 and 17½, who are usually required to have had at least a year's secondary school education.

(2) Men over the age of 18, who are required to be in the possession of a first-class Postmaster-General's Certificate, or its equivalent in knowledge of wireless and Morse speed.

DISTINGUISHING BADGE OF THE ROYAL NAVAL AIR SERVICE.

Further instruction is carried out at the R.N.A.S. Central Training Establishment in Lincolnshire, and it is here Class (1) receive all the training necessary to fit them for their positions. These lads are paid at the rate of 1s. per day and undergo a period of instruction varying from six to twelve months. On reaching the age of 18, if they succeed in passing their qualifying examinations, they are rated as air mechanics of the 2nd grade, and proceed along the regular lines detailed below.

The men belonging to Class (2) above undergo a period of training of approximately three months, and receive instruction in all forms of air service wireless apparatus. All air service wireless telegraph operators are liable to be called upon to make ascents in aircraft of any description—aeroplanes, seaplanes or airships, and are required to possess, before being regarded as proficient, such a sufficient knowledge of naval and aeronautic matters as will render them of value in the capacity of observers, and put them in a position to render assistance to the pilot in cases of necessity.

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The following constitute the grades of the R.N.A.S., and promotion from one to the other goes by selection and proved efficiency. The pay of the rank is appended in each case. Air Mechanics, 2nd grade, 2s.; acting air mechanics, 1st grade, 3s.; air mechanic, 1st grade, 4s.; leading mechanic, 5s.; petty officer mechanic, 6s.; chief petty officer mechanic, 3rd grade, 7s.; 2nd grade, 9s.; 1st grade, 10s. 6d.; warrant officer, 2nd grade, 11s.; first grade, 12s.

The BADGES for the R.N.A.S. Service are indicated in our illustration. They consist of a pair of wings surmounting the letters W.T. These distinguishing badges are worn on the right sleeve, whilst the rank held by the wearer is indicated in the usual manner on the left sleeve.

Royal Flying Corps.—The story of the formation of the Royal Flying Corps possesses in itself a great deal of interest, but must not detain us here further than is warranted by its connection with wireless operating. The men who have become familiar objects in the streets of London through attendance at Marconi House and the Regent Street Polytechnic for wireless instruction are not, except in very special cases, required to make aerial ascents. Their duty is to stand by the gunnery officers and receive aeroplane messages, besides erecting the aerials in order to enable this to be carried out. As a general rule, the arrangements are that the men shall work in gangs of three. They are enlisted at the Regent Street Polytechnic, where over 16,000 R.F.C. men have been enrolled, and thence go to Farnborough for two or three weeks' strenuous drill, after which they are entered for a course of instruction in one of the schools, either at Farnborough or in London. The course of instruction given them consists of a course in elementary electricity and magnetism, besides technical training in the manipulation of wireless apparatus. This scholastic work proceeds *pari passu* with instruction in wireless operating, flash-lamp signalling, and aerial erection drill. The length of the course is determined by the capacity of the student, and varies from three to six months. These men are enlisted usually between the ages of 17½ and 19. The proficiency required is not up to the standard of the first-class Postmaster-General's Certificate, but only that of the third class. After they have finished their courses, the men enter the service as second-class air mechanics, at a pay of 2s. per day, rising subsequently as they prove themselves worthy of promotion to be first-class air mechanics with a pay of 4s. per day. From privates they may become corporals at 5s. and sergeants

GROUP OF ROYAL FLYING CORPS.

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at 6s. per day, flight sergeants at 7s. per day, second-class warrant officers at 8s. per day, or first-class warrant officers at 9s. per day. Promotion goes by seniority and merit. The men who do the actual flying are commissioned flying *officers*, divided into two branches, (*a*) pilots, and (*b*) observation officers, both of whom receive their training at Farnborough. Pilots wear on the left breast a badge consisting of two wings with R.F.C. in between them; the observation officers bear on the left breast a badge with one wing springing from an O. These badges figure in our illustrations on page 626.

The commissioned ranks in the Royal Flying Corps comprise: Second-lieutenants, lieutenants and flying officers (observers) with the pay respectively of 7s. 6d., 8s. 6d., and 12s. daily, *plus* an additional flying pay of 5s. per diem in each case; adjutants, who receive 17s. per diem; flying officers, whose pay varies according to service, between 12s. and 16s.; flight commanders, with pay rising from 17s. to 23s. daily; and squadron commanders, whose ordinary pay amounts to 25s. The four last mentioned ranks have an additional flying pay of 8s. per diem.

Patent Record

6329. May 3rd. R. D'Antonio. Telegraphic transmission devices.

6256. May 2nd. J. Hettinger. Aerial conductors for wireless telegraphy.

6700. May 10th. J. T. Morris and A. F. Sykes. Means for locating subaqueous sounds.

6998. May 16th. W. A. Solomon. Systems of wireless telegraphy and telephony.

7088. May 18th. F. Rosso. Systems of radio-telegraphy for multiple simultaneous transmission. (Convention date, Italy, May 18th, 1915. *Open to public inspection.* Patent number, 100,495.)

7456. May 25th. S. Ford and A. F. Sykes. Electro-chemical microphone for wireless telegraphy and telephony.

7488. May 26th. W. H. Bragg. Apparatus for determining direction of sounds in water.

7543. May 27th. C. M. Bostock and R. N. Coke. Morse signalling for air-craft.

8011. June 6th. British Thomson-Houston Co., Ltd. (General Electric Co., U.S.A.). Wireless signalling systems.

8042. June 7th. I. J. Trim. Ear protectors for wireless telegraphic head receivers.

8303. June 12th. T. B. Dixon. Transforming motion into electrical waves or impulses. (Convention date, U.S.A., July 19th, 1915.)

8633. June 19th. British Westinghouse Electrical and Manufacturing Co. Alternating current commutator. (Convention date, U.S.A., June 19th, 1915.)

8845. June 23rd. C. H. Burdon (Siemens & Halske A.G.). Electro-magnetic relays.

9076. June 28th. H. Munro. Means for determining direction from which sounds proceed and distance at which it originates.

9105. June 28th. F. G. Simpson. Electric spark gap. (Convention date U.S.A., March 20th, 1915.)

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The Government and Inventions

AN INTERESTING ORDER IN COUNCIL

The following Order, which we reprint from the "London Gazette," will, we think, interest all of our readers.

At the Court at Windsor Castle, the 7th day of September 1916.

PRESENT:

The King's Most Excellent Majesty in Council.

WHEREAS by an Order in Council, dated the twenty-eighth day of November nineteen hundred and fourteen, His Majesty was pleased to make Regulations (called the "Defence of the Realm (Consolidation) Regulation 1914") under the Defence of the Realm Consolidation Act, 1914, for securing the public safety and the defence of the realm:

AND WHEREAS the said Act has been amended by the Defence of the Realm (Amendment) Act, 1915, the Defence of the Realm (Amendment) (No. 2) Act, 1915, and the Munitions of War Act, 1915:

AND WHEREAS the said Regulations have been amended by various subsequent Orders in Council:

AND WHEREAS it is expedient further to amend the said Regulations in manner hereinafter appearing,

Now, therefore, His Majesty is pleased, by and with the advice of His Privy Council to order, and it is hereby ordered, that the following amendments be made in the said Regulations:

1. After Regulation 8c the following regulation shall be inserted:

"8cc.—It shall be lawful for the Admiralty or Army Council or Minister of "Munitions with a view to the more efficient or increased production of war material "to require any person to communicate to a person nominated for that purpose "by the Admiralty, Army Council or Minister of Munitions all such particulars "as may be in his possession of any invention, or process or method of manufacture, "or of any article manufactured or proposed to be manufactured, and to furnish "drawings, models, or plans thereof, and to explain and demonstrate the same to "such person in all or any of its uses and workings; and if any person fails or "neglects to comply with any such requirement he shall be guilty of an offence "against these regulations; and if the requirement is addressed to a company, "every director, manager or officer of the company who fails or neglects to comply "with such requirement shall also be guilty of an offence against these regulations.

"If any person, except as authorised by the Admiralty or Army Council or "Minister of Munitions discloses or makes use of any information obtained in conse-"quence of any requirement made under this regulation or communicated to him "by the person by whom it was so obtained, he shall be guilty of an offence against "these regulations.

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" No communication of an invention made in consequence of any requirement " under this regulation, or the use thereof by any person authorised under this " regulation to use it, shall prejudice any right of the inventor or owner thereof " subsequently to apply for or obtain a patent for the invention."

2. After Regulation 19 the following regulation shall be inserted :

" 19a. If any person, having in his possession or under his control any document, " note, photograph, sketch, plan, design, model, pattern, specimen, or article (in- " cluding any key or other instrument affording means of access to information) of " such a nature as is calculated to be, or might be, directly or indirectly useful to " the enemy :

" (*a*) without lawful authority destroys, makes away with, or allows any person " to inspect or to be in possession of such document, note, photograph, sketch, " plan, design, model, pattern, specimen, or article as aforesaid : or

" (*b*) loses, fails to take reasonable care of, or so conducts himself as to endanger " the safe custody of such document, note, photograph, sketch, plan, design, model, " pattern, specimen or article as aforesaid : or

" (*c*) retains such document, note, photograph, sketch, plan, design, model, " pattern, specimen, or article as aforesaid in his possession or control when he has " no right to retain it, or when it is contrary to his duty to retain it : or

" (*d*) fails to comply with any directions issued by lawful authority with regard " to the custody, production, or the return of such document, note, photograph, " sketch, plan, design, model, pattern, specimen, or article as aforesaid ; he " shall be guilty of an offence against these regulations, and if any person, without " lawful authority or excuse, has in his possession or under his control any document, " note, photograph, sketch, plan, design, model, pattern, specimen or article as " aforesaid, he shall be guilty of an offence against these regulations."

3. After Regulation 40b the following regulation shall be inserted :

" 40c. If any man of His Majesty's reserve forces not for the time being subject " to the Naval Discipline Act or to Military Law, when under orders to report himself " for medical examination, malingers or feigns any disease or infirmity, he shall be " guilty of an offence against these regulations.

" If any such man produces any disease or infirmity in himself, or maims or " injures himself or causes himself to be maimed or injured or takes or uses any drug " or preparation, or does any other act, calculated or likely to render him, or to " lead to the belief that he is, permanently or temporarily unfit for service, he shall " be guilty of an offence against these regulations unless he proves that he did not " so act with the intent of escaping service.

" If any person :

" (*a*) wilfully produces any disease or infirmity in, or maims or injures, any " such man of His Majesty's reserve forces, or any man belonging to any other " of His Majesty's forces, whether or not he knew that the man was such a man as " aforesaid : or

" (*b*) with the intent of enabling any such man to render himself, or induce the " belief that he is, permanently or temporarily unfit for service, supplies to or for " such a man any such drug or preparation as aforesaid ;

" he shall be guilty of an offence against these regulations.

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4. After Regulation 42 the following regulation shall be inserted:

"42a. If any person attempts to induce a member of any of His Majesty's "forces to act in a manner which such person knows to be in contravention of the "King's Regulations and Admiralty Instructions or Admiralty Orders as respects "the Navy, or the King's Regulations or Army or other Orders as respects the "Army, he shall be guilty of an offence against these regulations."

ALMERIC FITZROY.

British Association and Radio-Telegraphic Investigations

IMPORTANT OBSERVATIONAL WORK.

THE observational work done for the British Association Committee on Radio-Telegraphy during the past year has, it is reported, been carried out at about 25 stations distributed in Australia, the United States of America, Canada, New Zealand, Ceylon, Trinidad, Dutch East Indies, Fiji and the Gold Coast.

Of the four kinds of forms issued by the Committee for the collection of statistics, the first, relating to the number and strength of the strays at 11 a.m. and 11 p.m. Greenwich mean time, has been in most regular use, and the stock is almost exhausted. No further edition of this form will be issued during the war, and thus the collection of statistics will come gradually to an end. The difficulty of obtaining clerical assistance for the work of reducing the forms has greatly impeded progress; but a certain amount of work has been accomplished and has yielded results of interest. So soon as the several sections of the work are rounded off the results will be published.

The reduction of Form I. is proceeding by the collation of records and reports of excessive atmospheric disturbance since August, 1914, in North America and Australia, and by their examination in conjunction with meteorological data from the corresponding daily weather charts.

The reduction of Form II. is proceeding by the correlation of instances of exceptionally good or bad transmissions with meteorological data, and by analysis of statistics from Cocus, Fiji, Lagos, Malta and Sierra Leone.

Several important exceptional phenomena have been reported which will, after discussion, be published. These include reports of—Aurora, Strays and Signals in Alaska and Hudson Bay; severe atmospheric disturbances in Malta; simultaneous strays on both sides of the Atlantic; and Effect of Tropical Storm in the Gulf of Mexico—September 30th, 1915.

Transpacific Wireless Communication

A TELEGRAM dated 5th October from San Francisco announces that in the course of a preliminary test direct wireless communication has been effected between the wireless station there and the Japanese Government plant at Ochiishi.

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The Calculation of the Capacity of Radio-telegraph Antennæ, including the Effects of Masts and Buildings

By PROFESSOR G. W. O. HOWE, D.Sc., M.I.E.E.

Paper read before the British Association for the Advancement of Science at Newcastle, 7 September, 1916.

(Continued from p. 556 of October Issue.)

It should be pointed out that the capacity here considered is that which would be measured by electrostatic or low-frequency methods, and is not necessarily the same as the effective capacity at radio frequencies. The latter will depend on the wave-length employed and on other factors which are beyond the scope of this Paper. To electrostatic measurements a wooden mast will act as an earthed conductor, whereas at radio frequencies its high resistance will considerably modify its effect on the capacity of the aerial. If the masts be of iron or steel and not insulated, and if, as is now common, the wave-length employed is considerably greater than the fundamental wave-length of the aerial, the effective capacity will agree closely with that calculated by the method here described.

We shall now apply the method to the inverted conical aerial of 160 wires, to which reference has already been made. We shall assume that it is supported by a ring of 10 masts 105 ft. high and 18 in. diameter, situated on a circle of 116 ft. diameter, as shown in Fig. 5. It is assumed, as before, that the induced charge on the masts is uniformly distributed and equal to q units per centimetre of length. To determine q, we have the average potential of the mast

due to its own charge	$=-$	$9{\cdot}27\,q$
,, the other masts	$=-$	$11{\cdot}74\,q$
,, the antenna	$=$	240
,, the image of the antenna	$=$	-135
,, the image of the masts	$=$	$8{\cdot}9\,q$

Of these five items, the first two and the last can be found accurately from Fig. 3 of this Paper; the other two are approximate, although they could be determined accurately if necessary. It is unfortunate that in this case the items which can be readily obtained with great accuracy are relatively unimportant. Since the mast is assumed to be earthed, its resultant potential must be zero, and therefore

$$(8{\cdot}9-9{\cdot}27-11{\cdot}74)q+240-135=0$$

and

$$q=8{\cdot}67 \text{ units per centimetre.}$$

We can now find the potential of the aerial, and we shall consider an average wire and not one situated close to a mast.

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The average potential of a wire

due to the nearest mast	=	− 22
,, all other masts	=	−117
,, the image of the mast	=	85
,, antenna without masts (previously found)	=	381
Total	=	327

Hence the effect of the masts is to lower the potential from 381 to 327, which will increase the capacity 16·5 per cent., *i.e.*, from 1,423 to 1,660 micro-microfarads. This is still only 62 per cent. of the measured value given for this antenna. Our calculation is based, however, on the assumption of 10 masts of 18 in. mean diameter; a greater number would, of course, still further increase the capacity. We have here neglected any horizontal wire from which the 160 wires may be suspended; we have already seen that such a wire might increase the capacity by 20 per cent.

THE CAPACITY OF WIRES NEAR BUILDINGS.

We shall consider in the first place a single vertical wire running close to the wall of a building. If the planes of the ground surface and of the wall be continued, and three images drawn symmetrically with regard to their intersection as shown in Fig. 6, then, on giving these images charges equal to that of the wire and of the signs shown in the figure, the planes will be equipotential surfaces, and will consequently have no effect on the potentials of the system. The potential of the wire will be made up of four components—viz., that due to its own charge, and those due to the three images. That due to its own charge can be read off Fig. 3 in the original Paper; that due to the earth image we have shown to be 1·38, if the lower end is almost touching the ground, but about 1·0 if the lower end is 3 ft. or 4 ft. above the ground. The potential of the wire due to its image in the wall can be read off Fig. 3 in this Paper, while that due to the diagonal image can also be obtained from Fig. 3 in the following manner. If two parallel vertical wires of length $2l$ are separated by a distance $2D$, the average potential of one due to unit charge per centimetre on the other can be read off Fig. 3; it is a function of the ratio l/D, which we may write $f(l/D)$. From considerations of symmetry, it is obvious that this is also the average potential of the upper half of the wire due to the whole length of the charged wire, whereas that due only to the upper half of the charged wire is $f(l/2D)$, which can also be read off Fig. 3. The difference, viz., $f(l/D) - f(l/2D)$ must be the average potential of the upper half of one wire due to the charge on the lower half of the other, and it is therefore the average potential of the aerial due to its diagonal image.

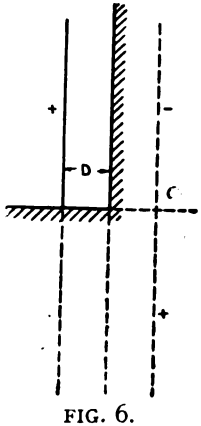

FIG. 6.

As an example, let $l = 100$ ft. of 0·1 in. diameter, and let $D = 6$ ft., then we have $l/r = 24{,}000$; $l/D = 16{\cdot}67$; and $l/2D = 8{\cdot}33$,

and $V_{av.} = 19{\cdot}53$ due to its own charge,
$-1{\cdot}38$ due to its earth image,
$-3{\cdot}85$ due to its wall image,
$+(5{\cdot}14 - 3{\cdot}85)$ due to its diagonal image.
$= 15{\cdot}6$.

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Hence its capacity is increased 16 per cent. by the proximity of the wall.

As a further example we may consider the case of four vertical wires 45 ft. long, 3 ft. apart, 0·1 in. diameter and 3 ft. from the wall.

$V_{av.}$ due to their own charge = $29{\cdot}9 \left(= \frac{135{\cdot}6}{4{\cdot}5}\right.$, *see* Fig. 10 in original Paper$\left.\right)$

,, earth image $= -\ 4{\cdot}0$ (approx.)

,, wall image $= -13{\cdot}3$ (Fig. 3 in this Paper)

,, diagonal image $= +\ 4{\cdot}0$ (approx.)

Total $= 16{\cdot}6$

The charge $= 4 \times 45 \times 30{\cdot}5 = 5{,}490$, and the capacity is therefore

$$\frac{5{,}490}{16{\cdot}6 \times 0{\cdot}9} = 368 \text{ micro-microfarads.}$$

If the distance from the wall be decreased to 1 ft., the capacity will be increased to 500×10^{-6} mfd.

This example is illustrative of an antenna mentioned by Professor Fleming, viz. : " Four vertical wires 0·1 diameter, each 45 ft. long, placed fan-shape in front of a building 6 ft. apart, bottom ends 10 in. apart, connected to a copper 'bus bar = 485 micro-microfarads." The distance from the wall and the details of the copper 'bus bar not being given, it is impossible to calculate the capacity accurately, but the above example shows that, given the necessary data, such cases can be calculated very readily.

As a further example of the method, we shall make an approximate calculation of the effect of the Eiffel Tower on the capacity of the antenna which is supported from it. The principal dimensions are shown in Fig. 7. The antenna consists of six wires of 7 mm. diameter. Each wire is about 330 metres long, and the average distance between adjacent wires is assumed to be 22 metres. Hence $l/d = 15$ and $d/r = 6{,}300$, and

$$C = \frac{16{\cdot}94n}{n\left(\log_e \frac{l}{d} - 0{\cdot}31\right) + \log_e \frac{d}{r} - B} = 5{\cdot}2 \times 10^{-6} \text{ mfd. per foot.}$$

(For B *see* Table IV. in the original Paper.)

The capacity of the antenna, apart from the effects of the earth and of the tower, would therefore be $5{,}620 \times 10^{-6}$ mfd. If charged with 1 unit per centimetre of wire, its average potential would be

$$\frac{6 \times 33{\cdot}9}{5{\cdot}2} = 39{\cdot}1 \text{ due to its own charge,}$$

and $$-\frac{6 \times 33{,}000}{27{,}500} = -7{\cdot}2 \text{ due to its image in the earth, giving a}$$

resultant potential of 31·9 and a capacity of

$$5{,}620 \times \frac{39{\cdot}1}{31{\cdot}9} = 6{,}900 \times 10^{-6} \text{ mfd.}$$

The proximity of the earth increases the capacity 22·7 per cent.

To form an estimate of the effect of the tower itself it is sufficient to assume that it is a vertical cylinder 300 metres high with a diameter of, say, 20 metres. (It is

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actually a lattice structure about 10 metres square near the top, 24 metres square in the middle, supported on four legs each 15 metres square, the centres of which form a square of 104 metres side.) Let the antenna be charged with 1 unit per centimetre of wire, and let this induce a charge of $-q$ units per centimetre of height of the tower.

The potential of the tower

Due to its own charge $= -6{\cdot}27\,q$ (*see* Fig. 3, $l_m/r_m = 30$)
,, its own image $= +1{\cdot}38\,q$ (*see* Fig. 21 *et seq.* in original Paper)
,, the antenna $= +16{\cdot}5$ (approx.)
,, the image of antenna $= -7{\cdot}0$ (approx.)

Since the tower is earthed, its potential is zero and $9{\cdot}5 - 4{\cdot}89\,q = 0$; therefore $q = 1{\cdot}94$.

The potential of the antenna due to the induced charge on the tower will be about $-2{\cdot}5\,q$, while that due to the image of the tower will be $1{\cdot}1\,q$, giving a resultant potential due to the tower and its image of $-1{\cdot}4\,q$ or $-2{\cdot}72$. The previously found potential of 31·9 will be reduced to 29·2, causing the capacity to be increased about 9 per cent. to $7{,}540 \times 10^{-6}$ mfd. *The actual measured capacity has been given as* $7{,}300 \times 10^{-6}$ mfd., but it must be remembered that the above calculation has only been carried out approximately upon very meagre data. To show the effect of a different assumption as to the equivalent diameter of the tower, it may be mentioned that taking 10 metres instead of 20 merely reduces the increase of capacity from 9 to 7 per cent.

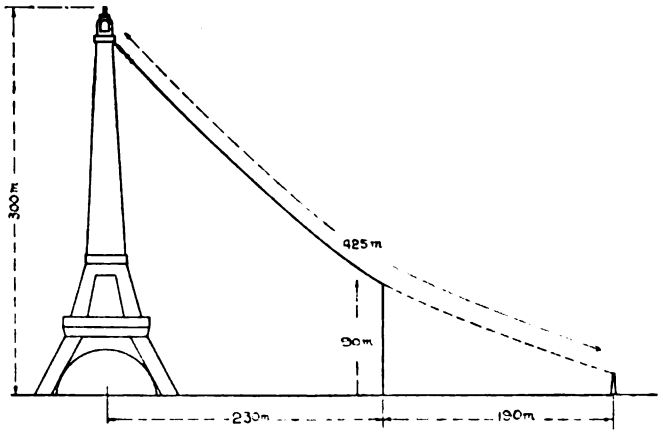

FIG. 7.

EXPERIMENTAL.

Seeing that the calculated values of the capacity differed very considerably in many cases from the values given as the result of actual measurement, and that sufficient data were not available to enable the effects of the masts, etc., to be allowed for in these measurements, it was thought essential to make some crucial tests to determine the accuracy which one might expect. For this purpose wires were stretched between insulators as shown in Fig. 8. The uprights and cross bars were of iron. The distance between the wires could be adjusted, and the separate wires could be insulated, earthed or connected together as desired. All the dimensions were accurately measured, and the capacity determined by a bridge method, using a buzzer and a telephone. Two of the arms consisted of a Paul inductionless ratio box with 1,000 ohms in each arm, while the other two consisted of variable air condensers.

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The capacity to be measured was substituted for one of these air condensers which had been accurately calibrated.

Length between supports	=114 ft. 5 in.
Length of each wire	=113 ft. 6 in.
Width between uprights	= 6 ft. 8 in.
Diameter of supports	=2·2 in.
Diameter of wire	=0·085 in. =0·21 cm.

The effect of the supports on the capacity of the wires was calculated but found to be negligible. The height of the wires above the ground was measured at different

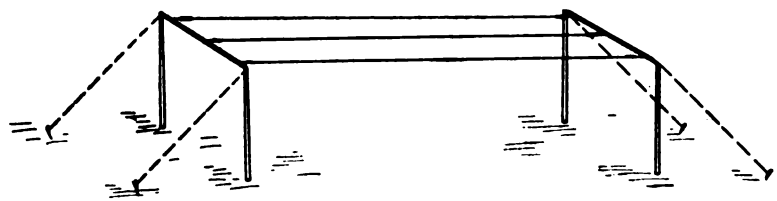

FIG. 8.

points and the mean taken in calculating the effect of the earth. The average height was about 1 metre. The results were as follows :—

Distance d Between Adjacent Wires.	Arrangement of Connections.	Capacity.		Percentage Difference.
		Calculated, 10^{-6} mfd.	Measured, 10^{-6} mfd.	
- -	Single solid wire (0·072 in.) ...	250	248	−0·8
- -	Ditto, but only 73 ft. 2 in. long ...	164	162	−1·2
- -	Stranded wire (7 × 0·028 in.) ...	256	260	1·6
4·7 cm.	Two ditto connected...	350	357	2·0
4·7 ,,	Cap. of one, the other earthed ...	341	330	−3·8
0·745 ,,	Three wires connected	310	335	8·0
0·745 ,,	Middle only, outers earthed... ...	770	788	2·3
1·65 ,,	Three wires connected	362	375	3·0
1·65 ,,	Middle only, outers earthed... ...	539	520	−3·5
2·8 ,,	Three wires connected	396	395	−0·25
2·8 ,,	Middle only, outers earthed... ...	454	450	−0·9
5·55 ,,	Three wires connected	432·5	425	−1·7
5·55 ,,	Middle only, outers earthed... ...	381	380	−0·26

It will be seen that the difference between the calculated and the measured value does not exceed 4 per cent., except in the very extreme case where the wires are only 7·45 mm. apart. Considering the difficulty of measuring such small capacities, the uncertainty introduced by connecting wires, and the difficulty of accurately determining the dimensions when stranded wires 113 ft. long are suspended in the open at distances of 1 cm. or 2 cm., the agreement must be considered very good with the exception of the case referred to. Here, however, the values of l/d and d/r are very extreme, and quite outside the range of the curves given in the original Paper for three-wire antennæ. The assumption of equal distribution of charge between the three wires is, therefore, far from true ; but it is a relatively simple

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matter to apply the method which we have already employed for finding the distribution of the charges in the cases in which the two outer wires were earthed. It is only necessary to determine the necessary distribution of charge between the three wires in order that they may all have the same average potential, as they must have, seeing that they are all connected.

Let the middle wire have a charge of 1 unit per centimetre, while the outer wires have q units per centimetre length. The potential of an outer wire

due to its own charge $= 20{\cdot}12\,q$ (Fig. 3 in original Paper)
,, the other outer $= 14{\cdot}9\,q$ (Fig. 3 in this Paper)
,, the inner wire $= 16{\cdot}28$ (Fig. 3 in this Paper)
,, the earth image $= -5{\cdot}48\,(1+2q)$ (Fig. 3 in this Paper)

(NOTE.—The average height above ground = 87 cm.)

The resultant potential of an outer wire $= 24{\cdot}06q + 10{\cdot}8$.

The potential of the inner wire

due to its own charge $= 20{\cdot}12$
,, the outer wires $= 2 \times 16{\cdot}28\,q$
,, the earth image $= -5{\cdot}48(1+2\,q)$

giving a resultant potential of $21{\cdot}6q + 14{\cdot}64$.

Since the two wires must have the same potential, we have

$$24{\cdot}06q + 10{\cdot}8 = 21{\cdot}6q + 14{\cdot}64$$

and

$$q = 1{\cdot}56.$$

Hence the charge on the outer wires has a density 1·56 times that on the middle wire.

The potential $= (24{\cdot}06 \times 1{\cdot}56) + 10{\cdot}8 = 48{\cdot}4$, and the charge per centimetre run of antenna $= 1 + 2q = 4{\cdot}12$ units. Hence the capacity

$$= \frac{4{\cdot}12 \times 3{,}450}{48{\cdot}4 \times 0{\cdot}9} = 326{\cdot}5 \text{ micro-microfarads,}$$

which differs by less than 3 per cent. from the measured value. A similar accurate calculation would also reduce the error of 3·6 per cent. found in the case of the three wires spaced at 1·65 cm. An accurate determination of the differences between the calculated and measured values obviously calls for measurements of far greater precision than those here recorded, but these are sufficient to show that, even in extreme cases, the author's method of calculating static capacity gives results of greater accuracy than is usually obtained in technical measurements of such small capacities.

[Photo: Bassano.

A RECENT PHOTOGRAPH OF PROF. HOWE.

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Among the Operators

INSPECTOR A. COBHAM.

S.S. "FRANCONIA."

ON this well-known Cunarder, recently reported by the Admiralty as sunk in the Mediterranean, two operators were carried—Travelling Inspector Alfred Cobham and Operator Hartley Smith. Inspector Cobham, who is 32 years of age, joined the Marconi Company in 1906, and was attached for some time to the Italian Agency. Upon returning from Italy he was appointed to the s.s. *Caronia*, and from this ship transferred, in August, 1911, to the s.s. *Franconia*, where he had remained ever since. In 1913 he was appointed travelling inspector.

The assistant operator, Mr. Hartley Smith, who is 21 years of age, received his P.M.G. Certificate at the Manchester Training College, Fallowfield, and joined the Marconi Company in January, 1915. He was first appointed to the *Adriatic*, and from this ship was transferred to the *Franconia* in September, 1915.

We are happy to say that, so far as we know, both men were rescued uninjured.

* * * * * *

S.S. "DEWA."

Another vessel recently sunk was the s.s. *Dewa*. Mr. John Geary, the operator-in-charge, is a Glasgow man, and received a preliminary wireless training at the North British Wireless School in that city. After a period of training in the Marconi Company's school in the Strand, he was appointed to the s.s. *Cassandra*, and from this ship was transferred to the s.s. *Orthia*. He later joined the s.s. *Tuscania* and the s.s. *Kioto*, transferring to the s.s. *Dewa* in April of this year. We are glad to say that he was rescued and is none the worse for his exciting experience.

* * * * * *

S.S. "SECONDO."

The s.s. *Secondo*, recently lost, carried as operator Mr. James Kilgannon, a native

OPERATOR HARTLEY SMITH.

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OPERATOR J. GEARY.

of the Wilson liner *Aaro*. We are glad to report that the operator of the vessel, Mr. Alfred Hardcastle, of Barnsley, Yorkshire, was among the saved, although he is now a prisoner of war in the internment camp at Brandenburg. Operator Hardcastle received his P.M.G. Certificate at the Manchester Wireless College, Fallowfield, and joined the Marconi Company about eighteen months ago. His first voyage was to America, on the s.s. *Feliciana*, and from this ship he transferred to s.s. *Shenandoah*,

OPERATOR A. HARDCASTLE.

of County Sligo. Mr. Kilgannon is 23 years of age and a comparatively recent recruit of the Marconi Company, having joined in February, 1916. He was first appointed to the s.s. *Athenia*, afterwards to the s.s. *Calonne*, and in September of this year to the s.s. *Secondo*. We congratulate Mr. Kilgannon on escaping uninjured from the wreck.

* * * * * *

S.S. "AARO."

Our readers will have learnt from the daily Press of the sinking by the enemy

OPERATOR J. KILGANNON.

on which he served for some seven months. We sincerely trust Mr. Hardcastle will receive good treatment in the hands of the enemy.

* * * * * *

DEATH FROM APOPLEXY.

We deeply regret to report the death of operator James Fennessy, who passed away on September 8th, after an attack of apoplexy. Mr. Fennessy, who was but 20 years of age at the time of his death, trained for the wireless service at the Atlantic Wireless School, Cahirciveen, and

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upon receiving his P.M.G. Certificate entered the Marconi Company just after the outbreak of war. His first ship was the s.s. *Numidian*, of the Allan Line, and he subsequently served on the s.s. *Ausonia*, *Holbein*, *Scandinavian*, *Brodmount*, *Cambria*, *Niwaru*, and *Colonian*. We take this opportunity of offering to Mr. Fennessy's relatives, both on our own part and on behalf of many friends among our readers, the sincerest sympathy in their great bereavement.

OPERATOR J. J. FENNESSY.

A New Use for the "Marconi Records"

Successful Demonstration at Preston

At the annual exhibition in connection with the Astro-Physical Section of the Preston Scientific Society, held October 9th-13th, Mr. J. H. Morris contributed to the exhibits a series of Marconi official gramophone records. Following our hint in a previous number of this magazine, a Deckert telephone transmitter was mounted on an arm attached to a battery box containing two Leclanche cells, a telephone induction coil and a switch to disconnect the cells completed the equipment at one end, and placed in an ante-room with the transmitter in the mouth of the trumpet of the gramophone. A twin line ran from this to the lecture hall and attached to terminals on a batten on which five telephones were connected in parallel. The signals were an exact replica of those heard on wireless installations, and proved a great source of interest to the visitors when telegraphists were transcribing the messages.

Special Notice

The December issue of The Wireless World will contain an important and highly interesting article on the famous wireless station at Arlington, near Washington. The article will not only be profusely illustrated with photographs and diagrams of connections, but will be based upon information officially supplied by the American Government.

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American Letter

New York, September 27th, 1916.

UNQUESTIONABLY the most important event of the present month is the decision rendered by His Honour Judge Mayer, of the United States District Court, regarding the suit which was tried before him covering the patents involved in the Fleming Valve controversy between the American Marconi Company and the De Forest Radio Telegraph and Telephone Company. The decision was handed down September 20th, 1916, and is a complete victory for the Marconi Company. (See page 644.—ED.) Unbiased technical and legal men in this country consider this decision as one of the finest and most technically correct opinions rendered from the Bench. This case should be of particular interest in Great Britain because the inventor, Professor Fleming, is a British subject.

The next meeting of the Institute of Radio Engineers will be held on Wednesday, October 4th, 1916, in the building of the American Institute of Electrical Engineers. A highly interesting paper will be presented by Mr. Edwin H. Armstrong, of Columbia University. The subject of the paper will be " The Heterodyne Theory of Amplification and its Relation to the Oscillating Audion." The paper is an expansion of the valuable results laid before the membership of the Institute by Mr. Armstrong in 1915. A large attendance is expected.

Much interest has been shown by persons connected with wireless and its allied subjects in the suit recently filed by the American Marconi Company against the United States Government. In its petition filed in the Court of Claims, the American Marconi Company asks $1,000,000.00 from the United States Government in payment of its patent rights, which it considers infringed.

Of particular interest to residents of Alaska is the fact that the American Marconi Company had made a substantial reduction in its telegraph rates, effective October 1st, 1916. The rate previously charged for messages from Seattle, Washington and Astoria, Oregon, to Juneau and Ketchikan, Alaska, was $1.25-12c. whereas the new rate is $1.00-10c.

It is a little over a year since the Marconi Company opened its Alaskan chain of wireless stations for public service, and the appreciation of the public doing business in that territory is evidenced by the volume of traffic handled by these stations. It is expected that the reduction in rates will popularise the service to an even greater extent.

Mr. Charles J. Pannill, who was formerly superintendent of the Southern Division of the American Marconi Company and later was appointed Commercial Traffic Superintendent of the Naval Radio Service, has recently been appointed Aide to the Director of Naval Communications at Radio, Virginia. Mr. Pannill recently visited the Pacific Coast branch of the Naval Communication Service.

DAVID SARNOFF.

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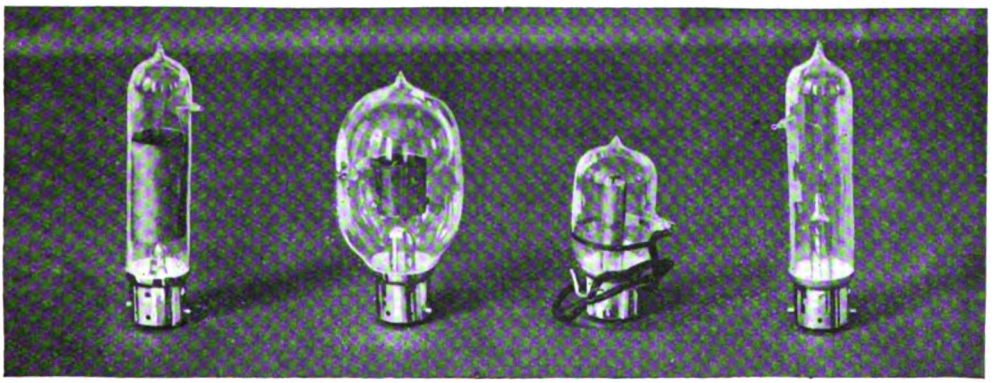
The Fleming Valve and the De Forest Audion

Important Patent Decision in the United States

MUCH of the recent progress in wireless telegraphy and telephony is due to modifications of the well-known Fleming valve detector, the construction and working of which will be familiar to most of our readers. In its three-electrode form it has proved to be the most sensitive of all receivers, and by special arrangement of circuits it can be made to produce continuous oscillations for wireless telegraph and telephone transmission. As an amplifier, too, it has great value, and it is safe to say that in one form or another it is used in practically all long-distance radiotelegraphy. Further, by utilising at the same time its properties as a detector and generator, it is possible to use it as a receiver for continuous waves, the circuits being arranged so as to give a " beat " effect, and consequently a pure musical note. For some years the Marconi engineers have been perfecting the Fleming valve in its various forms, particularly as an amplifier and oscillation generator. In this latter form it enabled Mr. Marconi, in the early part of 1914, to carry out some highly successful wireless telephone experiments between vessels of the Italian Navy. It will be remembered that with only a very limited energy a distance of 45 miles was easily attained.

Before the outbreak of war considerably greater distances than this had been achieved, and it is practically certain that had not the European conflict diverted the energies of the Marconi Company into other channels, transatlantic wireless telephony would have been an accomplished fact much earlier than was actually the case. As, however, the United States were free to continue wireless experiments while Europe was engaged in the gigantic struggle, to that country fell the honour of the first transatlantic wireless telephone communication, which was reported in



SOME FORMS OF THE FLEMING VALVE.

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our December issue. The success of these experiments was due entirely to the use of the oscillation-generating form of the Fleming valve.

At an early date we hope to publish a technical article, describing in detail the various modern forms of the vacuum valve and just how the circuits are arranged to produce the various effects referred to above. Enough has been said here, however, to show that this piece of apparatus is of the utmost importance in the science of wireless communication.

For a considerable time the Courts of the United States had been occupied in an action brought by the Marconi Company against Dr. Lee De Forest for infringement of their Fleming valve patents, and a counter-action by De Forest claiming damages for infringement by the Marconi Company. Dr. De Forest is well known in connection with radiotelegraphy in the United States, as for some years he has manufactured, demonstrated and sold various modifications of the Fleming valve, to which he has given the title of audion, ultraudion, oscillion, etc. He has also claimed the credit for inventing this form of apparatus. The long law action has now, however, been concluded, and on September 21st judgment was given in favour of the Marconi Company, Dr. Fleming's patents being declared to be master patents and not anticipated by De Forest or anybody else. The De Forest audion was held to be an infringement of the Marconi Company's Fleming patents.

In Germany and at German stations abroad considerable use has been made of the improved Fleming valve, and what success the Germans have attained in transatlantic communication has largely been due to its use. The Atlantic Communication Company of America, a subsidiary company of the Telefunken Company of Berlin, and the firm responsible for the working of the giant Sayville station at Long Island, has infringed a number of patents in order to obtain a wireless service across the Atlantic, and fearing the action by the Marconi Company against them, which is pending, recently purchased the De Forest patent rights for the sum of £30,000. They will now have reason to regret their bargain.

This is not the first patent action which the Marconi Company has brought against Dr. De Forest. In 1905 Judge Townsend, in New York, decided in favour of the Marconi Company in its action against the De Forest Wireless Telegraph Company for infringement of certain fundamental patents.

The Basis of Promotions

MANY employés labour under the belief that they are entitled to promotion to higher positions by reason of long service alone, without any reference to ability and general fitness, but when the time comes for the selection of one to fill a higher position they are always side-tracked.

Telegraph and telephone companies are strictly business concerns and do not fill positions of responsibility with persons who are not qualified to fill them. Operators themselves are subject to the same law. They hold their positions because they are able to perform the duties of their positions, and so it is all along the line up to the highest place. Experience stands supreme yet, and always will.—*Telegraph and Telephone Age.*

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Foreign and Colonial Notes

FRANCE.

THE French Marine Commission has decided to appoint nine Commissioners, who, with the delegates of the French Navy, shall control the installation of wireless telegraphy and armaments of mercantile ships and the rules for the navigation of such ships (*The Times*).

* * * * * *

SWEDEN.

The Swedish Press is urging the Government to take steps to prevent the misuse of the Swedish wireless stations by foreign ships trading in the Swedish waters. It is reported that the telegraph authorities have now taken such measures as will make the use of the Swedish wireless system for trade espionage impossible.

* * * * * *

UNITED STATES.

The power plant of the field wireless station at General Pershing's headquarters in Mexico was doubled recently, inaugurating one of the first of the military improvements suggested by the Mexican campaign.

The sending of naval wireless messages on both coasts of North America can be read nightly by this station, but on account of lack of sufficient power it usually has been unable to send even as far as Columbus at night. Daylight conditions are better for wireless operations, owing to the incessant rattle of static at night.

* * * * * *

A course in wireless telegraphy is to be added to the curriculum of the University of Kansas next year. Laurens E. Whittemore, a Fellow in the department of physics, will conduct the course, and he intends to make the wireless station in Lawrence one of the largest in the State outside of those owned and controlled by the Government.

The present outfit established by Whittemore is capable of sending messages more than 1,000 miles, and has picked up parts of messages from as far as Key West. The course is expected to prove extremely popular in the next two years.

* * * * * *

A wireless station has been installed, and is now in operation, at Navassa Island Light Station, West Indies, now under construction. This radio station is operated at present by the contractors for the erection of a light station, and it will be worked by the United States Lighthouse Service when the light station is completed.

* * * * * *

A new type of American aeroplane, with a special helmet for the pilot designed to muffle the deafening motor explosions and make possible the receiving of wireless messages, was recently tested in the United States, says the *Daily Express*. Reception of wireless messages on aeroplanes is no new thing, and a suitable receiving apparatus has been in use at the front for a long time.

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Instructional Article

NEW SERIES (No. 15).

The following series, of which the article below forms the fifteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Trigonometrical Ratios of the Sum of Two Angles.

98. In Fig. 87 the line QR, "hinged" at Q, has, starting from the position QP, swept out an angle $PQR=A$, and has then gone on further and swept out a second angle $RQS=B$, thus describing the total angle $PQS=(A+B)$. We will now set to work to find convenient expressions, giving the values of sin $(A+B)$, cos $(A+B)$ and tan $(A+B)$ in terms of the sine, cosine and tangent of A and of B.

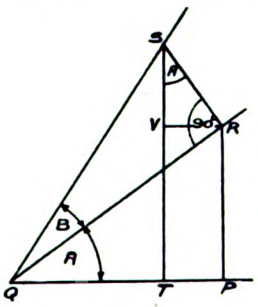

FIG. 87.

From any convenient point S on the final position QS of the radial line, drop perpendiculars ST and SR on to QP and QR respectively. Next draw RP perpendicular to PQ; and then RV parallel to PQ, cutting ST at V. We see that RV is perpendicular to both ST and RP.

In the triangle RSV we know that the sum of the three angles is 180°, and we also know that the angle $SVR=90°$. Therefore

$$V\hat{S}R+V\hat{R}S=180°-S\hat{V}R$$
$$=180°-90°=90°$$
$$\text{or}\quad V\hat{S}R=90°-V\hat{R}S.$$

But we made $Q\hat{R}S=90°$,

and therefore $V\hat{S}R=90°-V\hat{R}S$

$$=Q\hat{R}S-V\hat{R}S=Q\hat{R}V.$$

But we also drew VR parallel to PQ, and therefore

$$Q\hat{R}V=R\hat{Q}P=A.$$

Therefore $$V\hat{S}R=A.$$

Having settled this, we can now go ahead with our proofs.

$$\sin(A+B)=\sin P\hat{Q}S=\frac{ST}{SQ}=\frac{SV+VT}{SQ}=\frac{SV+RP}{SQ}=\frac{SV}{SQ}+\frac{RP}{SQ}.$$

$$\cos(A+B)=\cos P\hat{Q}S=\frac{QT}{SQ}=\frac{QP-PT}{SQ}=\frac{QP-VR}{SQ}=\frac{QP}{SQ}-\frac{VR}{SQ}.$$

Now if we multiply the numerator and the denominator of a fraction by the same quantity, the value of the fraction remains unchanged.

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Multiply $\frac{SV}{SQ}$ by SR

and $\frac{RP}{SQ}$ by RQ

Then $\sin(A+B)$

$$=\frac{SV.SR}{SR.SQ}+\frac{RP.RQ}{RQ.SQ}$$

$$=\cos A\,.\,\sin B+\sin A\,.\,\cos B$$

or

$$\sin(A+B)=\sin A\,.\,\cos B+\cos A\,.\,\sin B.$$

Multiply $\frac{QP}{SQ}$ by QR

and $\frac{VR}{SQ}$ by SR

Then $\cos(A+B)$

$$=\frac{QP.QR}{QR.SQ}-\frac{VR.SR}{SR.SQ}$$

or

$$\cos(A+B)=\cos A\,.\,\cos B-\sin A\,.\,\sin B.$$

Now $$\tan(A+B)=\frac{\sin(A+B)}{\cos(A+B)}$$

$$=\frac{\sin A\,.\,\cos B+\cos A\,.\,\sin B}{\cos A\,.\,\cos B-\sin A\,.\,\sin B}.$$

In order to obtain this formula in the tangent form we divide all along the numerator and denominator by $(\cos A\,.\,\cos B)$. Thus—

$$\tan(A+B)=\frac{\frac{\sin A\,.\,\cos B}{\cos A\,.\,\cos B}+\frac{\cos A\,.\,\sin B}{\cos A\,.\,\cos B}}{\frac{\cos A\,.\,\cos B}{\cos A\,.\,\cos B}-\frac{\sin A\,.\,\sin B}{\cos A\,.\,\cos B}}=\frac{\frac{\sin A}{\cos A}+\frac{\sin B}{\cos B}}{1-\frac{\sin A}{\cos A}\,.\,\frac{\sin B}{\cos B}}$$

$$=\frac{\tan A+\tan B}{1-\tan A\,.\,\tan B}.$$

Trigonometrical Ratios of the Difference of Two Angles.

99. We can quite easily employ the method of Section 98 to finding the sine, cosine and tangent of $(A-B)$ instead of $(A+B)$. We shall, however, require a slightly different geometrical construction.

In Fig. 88 the radial line has swept out an angle $PQR=A$, and has then *reversed* and swept out an angle $RQS=B$. We thus have the angle $PQS=(A-B)$.

As before, we take some convenient point S on the final position of the line, and from this point drop perpendiculars SP and SR on to QP and QR respectively. RT is then drawn perpendicular to PQ, and SV parallel to PQ. Then

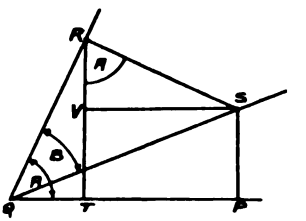

FIG. 88.

$$V\hat{R}S=Q\hat{R}S-Q\hat{R}T=90^\circ-Q\hat{R}T=R\hat{Q}T=A.$$

The proofs which follow are very similar indeed to those in the preceding paragraph

$$\sin(A-B)=\sin P\hat{Q}S=\frac{PS}{SQ}=\frac{VT}{SQ}=\frac{RT-RV}{SQ}=\frac{RT}{SQ}-\frac{RV}{SQ}=\frac{RT.QR}{QR.SQ}-\frac{RV.RS}{RS.SQ}$$

$$\sin(A-B)=\sin A\,.\,\cos B-\cos A\,.\,\sin B.$$

$$\cos(A-B)=\cos P\hat{Q}S=\frac{PQ}{SQ}=\frac{PT+TQ}{SQ}=\frac{SV+TQ}{SQ}=\frac{SV}{SQ}+\frac{TQ}{SQ}=\frac{SV.RS}{RS.SQ}+\frac{TQ.QR}{QR.SQ}$$

$$\cos(A-B)=\sin A\,.\,\sin B+\cos A\,.\,\cos B$$

or $\cos A\,.\,\cos B+\sin A\,.\,\sin B.$

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Again,

$$\tan (A-B)=\frac{\sin (A-B)}{\cos (A-B)}$$

$$=\frac{\sin A.\cos B-\cos A.\sin B}{\cos A.\cos B+\sin A.\sin B}=\frac{\dfrac{\sin A.\cos B}{\cos A.\cos B}-\dfrac{\cos A.\sin B}{\cos A.\cos B}}{\dfrac{\cos A.\cos B}{\cos A.\cos B}+\dfrac{\sin A.\sin B}{\cos A.\cos B}}$$

$$=\frac{\dfrac{\sin A}{\cos A}-\dfrac{\sin B}{\cos B}}{1+\dfrac{\sin A}{\cos A}.\dfrac{\sin B}{\cos B}}=\frac{\tan A-\tan B}{1+\tan A.\tan B}.$$

Example:

If $\sin A=\frac{4}{5}$ and $\tan B=\frac{9}{40}$, find $\cos (A+B)$.

In Fig. 89 (*a*) we have our usual right-angled triangle PQR. Angle $Q=90°$, and angle $P=A$. As we know that $\sin A=\frac{4}{5}$, we know that $QR=4$ and that $PR=5$.

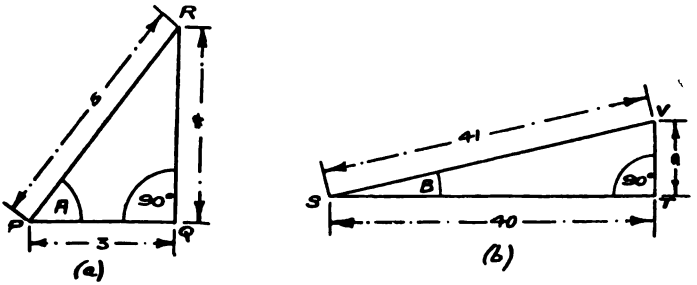

FIG. 89.

Thus $PQ=\sqrt{PR^2-RQ^2}=\sqrt{25-16}=\sqrt{9}=3$.

From this $\cos A=\frac{3}{5}$.

Similarly, in Fig. 89 (*b*) we deal with angle B, and we see that if angle $S=B$, then $VT=9$ and $ST=40$.

From this we get

$SV=\sqrt{(40)^2+(9)^2}=\sqrt{1600+81}=\sqrt{1681}=41$.

Therefore $\sin B=\frac{9}{41}$

and $\cos B=\frac{40}{41}$.

Thus $\cos (A+B)=\cos A.\cos B-\sin A.\sin B$

$$=\frac{3}{5}.\frac{40}{41}-\frac{4}{5}.\frac{9}{41}$$

$$=\frac{120}{205}-\frac{36}{205}=\frac{84}{205}=0{\cdot}41.$$

From tables $(A+B)=\cos^{-1}0{\cdot}41$

$=65°\ 48'$ (approx.).

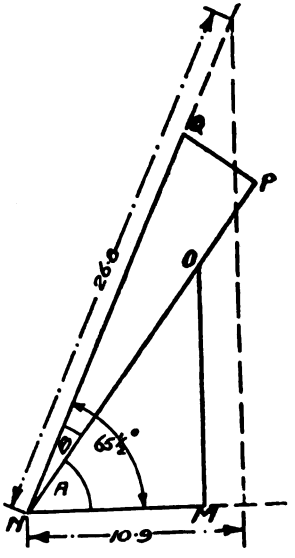

FIG. 90.

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These results are verified in Fig. 90.

Here $M\hat{N}O$ is drawn, to scale, as angle A, and on NO produced is erected the angle $PNQ=B$. The obvious way to do this is to make $N\hat{M}O=90°$, and make $MO=4$ and $NM=3$. (Then NO *must* equal 5.)

Similarly $NP=40$, $PQ=9$ and $N\hat{P}Q=90°$. (In this case NQ *must* equal 41.) Note that different scales are used, for convenience, for drawing A and B.

Scaling off from this figure, we get

$$(A+B)=65\tfrac{1}{2}° \text{ and } \cos(A+B)=\frac{10\cdot9}{26\cdot8}=0\cdot407.$$

Example:

Find (i.) sin 75° and (ii.) tan 105°.

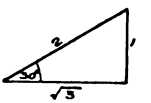
(i.) Sin $75°=\sin(45°+30°)$

$=\sin 45°\cdot\cos 30°+\cos 45°\cdot\sin 30°.$

Now $\sin 45°=\frac{1}{\sqrt{2}}$ $\cos 45°=\frac{1}{\sqrt{2}}$

$\sin 30°=\frac{1}{2}$ $\cos 30°\cdot\frac{\sqrt{3}}{2}$

Therefore $\sin 75°=\frac{1}{\sqrt{2}}\cdot\frac{\sqrt{3}}{2}+\frac{1}{\sqrt{2}}\cdot\frac{1}{2}$



$=\frac{\sqrt{3}}{2\sqrt{2}}+\frac{1}{2\sqrt{2}}=\frac{\sqrt{3}+1}{2\sqrt{2}}$

$=\frac{1\cdot732+1}{2\times1\cdot414}=\frac{2\cdot732}{2\cdot828}=0\cdot966$ (approx.).

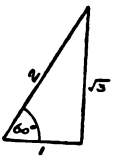
[From Tables—sin $75°=0\cdot9659$.]

(ii.) Tan $105°=\tan(60°+45°)$

$=\frac{\tan 60°+\tan 45°}{1-\tan 60°\cdot\tan 45°}.$

Now $\tan 60°=\frac{\sqrt{3}}{1}=\sqrt{3}$

and $\tan 45°=\frac{1}{1}=1$.



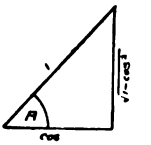
Therefore $\tan 105°=\frac{\sqrt{3}+1}{1-\sqrt{3}\times1}=\frac{1\cdot732+1}{1-1\cdot732}$

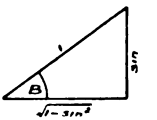
$=\frac{2\cdot732}{-0\cdot732}=-\frac{2\cdot732}{0\cdot732}=-3\cdot73$ (approx.).

[From Tables—$\tan 105°=-\tan 75°=-3\cdot732$.]

Example:

Given that $\cos A=0\cdot2$ and $\sin B=0\cdot4$, find $\tan(A-B)$.





Working as in Article XIV., we have—

$$\tan A=\frac{\sqrt{1-\cos^2 A}}{\cos A}=\frac{\sqrt{1-(0\cdot2)^2}}{0\cdot2}=\frac{\sqrt{1-\cdot04}}{\cdot2}=\frac{\sqrt{\cdot96}}{\cdot2}=\frac{\cdot98}{\cdot2}=4\cdot9.$$

We have also

$$\tan B=\frac{\sin B}{\sqrt{1-\sin^2 B}}=\frac{0\cdot4}{\sqrt{1-(0\cdot4)^2}}=\frac{0\cdot4}{\sqrt{1-0\cdot16}}=\frac{0\cdot4}{\sqrt{0\cdot84}}=\frac{0\cdot4}{0\cdot9165}=0\cdot436.$$

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Thus $\tan(A-B)=\dfrac{\tan A-\tan B}{1+\tan A\,.\,\tan B}$

$$=\frac{4\cdot9-0\cdot436}{1+4\cdot9\times0\cdot436}=\frac{4\cdot454}{1+2\cdot14}=\frac{4\cdot454}{3\cdot14}=1\cdot42.$$

Thus $(A-B)=\tan^{-1}1\cdot42$

$=55°$ (nearly).

Examples for Practice:

21. Evaluate the following by means of the foregoing addition and subtraction theorems:

(*a*) cos 75° (*c*) sin 105°

(*b*) tan 75° (*d*) sec 195° (195°=135°+60° and 135°=90°+45°).

22. Given sin 55°=0·82 and cos 20°=0·94, find (*a*) sin 75°, (*b*) cos 35° and (*c*) tan 75°.

100. In the preceding paragraphs we obtained the following important formulæ:

$$\sin(A+B)=\sin A\cos B+\cos A\sin B \quad . \quad . \quad . \quad (1)$$
$$\sin(A-B)=\sin A\cos B-\cos A\sin B \quad . \quad . \quad . \quad (2)$$
$$\cos(A+B)=\cos A\cos B-\sin A\sin B \quad . \quad . \quad . \quad (3)$$
$$\cos(A-B)=\cos A\cos B+\sin A\sin B \quad . \quad . \quad . \quad (4)$$
$$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\,.\,\tan B} \quad . \quad . \quad . \quad (5)$$
$$\tan(A-B)=\frac{\tan A-\tan B}{1+\tan A\,.\,\tan B} \quad . \quad . \quad . \quad (6)$$

Now let us take formulæ (1) and (2)

$$\sin(A+B)=\sin A\,.\,\cos B+\cos A\,.\,\sin B$$
$$\sin(A-B)=\sin A\,.\,\cos B-\cos A\,.\,\sin B$$

Adding— $\sin(A+B)+\sin(A-B)=2\sin A\cos B$. (7)

Subtracting— $\sin(A+B)-\sin(A-B)=2\cos A\sin B$. (8)

Now let us put C for $(A+B)$

and D for $(A-B)$

Then $\left(\dfrac{C+D}{2}\right)=\dfrac{(A+B)+(A-B)}{2}=\dfrac{2A}{2}=A$

and $\left(\dfrac{C-D}{2}\right)=\dfrac{(A+B)-(A-B)}{2}=\dfrac{2B}{2}=B.$

Substituting these values in equations (7) and (8), we get—

$$\sin C+\sin D=2\sin\left(\frac{C+D}{2}\right)\cdot\cos\left(\frac{C-D}{2}\right) \quad . \quad . \quad (9)$$

and $$\sin C-\sin D=2\cos\left(\frac{C+D}{2}\right)\cdot\sin\left(\frac{C-D}{2}\right) \quad . \quad . \quad (10)$$

Similarly, dealing with formulæ (3) and (4)—

$$\cos(A+B)=\cos A\cos B-\sin A\sin B$$
$$\cos(A-B)=\cos A\cos B+\sin A\sin B$$

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Adding— $\cos(A+B)+\cos(A-B)=2\cos A\,.\cos B$

Subtracting—$\cos(A+B)-\cos(A-B)=-2\sin A\sin B=2\sin A(-\sin B)$
$=2\sin A\sin(-B)$ because $-\sin B=\sin(-B)$
(Art. 7.)

Substituting as before—

$$\cos C+\cos D=2\cos\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right) \quad . \quad . \quad (11)$$

and $$\cos C-\cos D=2\sin\left(\frac{C+D}{2}\right)\sin\left\{-\left(\frac{C-D}{2}\right)\right\}$$

or $$\cos C-\cos D=2\sin\left(\frac{C+D}{2}\right)\sin\left(\frac{D-C}{2}\right) \quad . \quad . \quad (12)$$

Answers to Questions in Art. XIV.

13. $\begin{cases} x=0, y=-1 \\ x=3, y=8. \end{cases}$

14. $\begin{cases} x=-3, y=4 \\ x=\frac{4}{7}, y=\frac{131}{14}. \end{cases}$

15. $\begin{cases} x=\frac{7}{2}, y=-\frac{5}{2} \\ x=-\frac{24}{7}, y=\frac{89}{42}. \end{cases}$

16. $\frac{x}{9}=\frac{y}{-17}=\frac{z}{-7}$.

17. $\frac{x}{3}=\frac{y}{1}=\frac{z}{11}$. (Note that the coefficient of z is 0.)

18. $\frac{x}{13}=\frac{y}{1}=\frac{z}{11}$.

19. (*a*) $\sin\theta=\frac{1}{\sqrt{1+\cot^2\theta}}$.

(*b*) $\tan\theta=\frac{\sqrt{1-\cos^2\theta}}{\cos\theta}$.

(*c*) $\cot\theta=\sqrt{\operatorname{cosec}^2\theta-1}$.

20. (*a*) $\cos\theta=0\cdot8$. (*b*) $\sec\theta=4\cdot12$. (*c*) $\cot\theta=9\cdot95$.
(*d*) $\cos\theta=1$ (approx.) $\sin\theta=0\cdot01$ (approx.) (*e*) $\tan\theta=0$.

Wireless Only

How the Bahamas were Saved from Isolation.

According to a Colonial Office report published recently, last year the sole means of telegraphic communication which the Bahama Islands enjoyed was by radio, which, during twelve months in which business was far greater than in any previous year, proved a very excellent substitute for the broken cable between Nassau and Florida.

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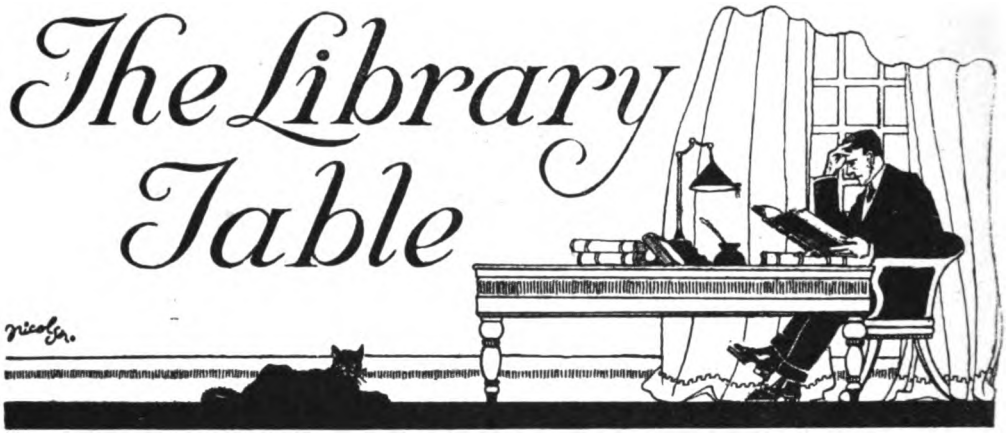
The Library Table



"EXPERIMENTAL WIRELESS STATIONS, THEIR THEORY, DESIGN, CONSTRUCTION AND OPERATION." Third Edition. By Philip E. Edelman. Published by the Author at Minneapolis, Minn., U.S.A. $1.50.

This is one of the best books on practical wireless that we have seen, and the new edition under review will doubtless meet with the same wide sale as the previous ones. It is evident upon first perusal that the author is thoroughly acquainted with his subject, and the designs of apparatus given are theoretically sound and thoroughly practical. Commencing with a brief chapter on theories of transmission, the author then deals with the design of aerials and earths, general features of transmitter resonance, damping, and allied subjects. Chapter V.—a particularly valuable one—is devoted to planning the transmitter, and here the reader will find clear instructions for the calculation of wave-length, capacity and circuits. Transformers and spark coils are then treated, after which we come to a consideration of auxiliary apparatus, including keys, electrolytic interrupters and aerial switches. Other chapters deal with transmitting condensers, inductance, spark coils, and hot wire ammeters.

Continuous waves and continuous wave apparatus have a chapter to themselves, and we then find some valuable information on the construction and working of receivers.

In order that the book may be brought right up to date the author has added a "1916 Supplement" dealing with aeroplane wireless, balancing aerials, the various new receivers which come under the general heading of "Vacuum Valves" (audions, pliotrons, etc.), transatlantic wireless telephony, long-wave stations, and a very useful little section on long-wave receivers.

Not the least valuable part of the book is the section devoted to the United States patents on wireless telegraphy, telephony and control. In this patents from 1881 to January 1st, 1916, are classified under various headings, such as general apparatus, receiving systems, secrecy systems, various forms of detectors, wavemeters, wireless telephony, and so on. We do not remember having seen such a classification before, and we are sure that many readers will welcome it with enthusiasm.

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The book is profusely illustrated with diagrams which are both clear and practical. As soon as the war is over, and amateur wireless enthusiasts are able to re-erect their apparatus, we are sure that a large number of them will profit by the excellent information contained in this book, and greatly improve their installations.

* * * * * *

"ENGLISH-FRENCH COMMERCIAL CORRESPONDENCE." By William Chevob-Maurice and C. Laroche. London: E. Marlborough & Co. 1s. net, wrapper; 1s. 6d. net, cloth.

One of the minor effects of the great war is to bring home to the British business man the need of a thorough knowledge of foreign languages, if he wishes to capture much of the trade which, prior to the outbreak of hostilities, was in the hands of the Germans. The aim of this handbook is to supply the commercial equivalent in French and English, and not merely a literal translation one of the other. In this way the correct phraseology is assured to the correspondent, whether he writes in English or in French. In the 126 pages of the book will be found practically everything that is required in general business correspondence—good, sound, common-sense letters, free from the affectation which mars so many books of this type. We can warmly recommend this little volume to all who require assistance in their correspondence with France and French-speaking countries.

* * * * * *

"ARITHMETIC FOR ENGINEERS." By Charles B. Clapham. London: Chapman & Hall, Ltd. 5s. 6d. net.

This book, which forms one of the "Directly Useful Technical Series," bears a title which is, to some extent, misleading. A glance at the index shows that not only general arithmetic but simple algebra, logarithms, graphs, and the slide rule are dealt with, so that the book would be far better entitled "Elementary Mathematics for Engineers." However, this title has apparently been used before.

The volume is designed to fill the place between theoretical books which have been written more for the training of college students than for the supply of information to men in practice, and the practical books which often run to the other extreme, omitting the scientific basis upon which all good practice is built. The explanations of all the subjects are clear and to the point, and the examples and exercises admirably chosen. For home students this work can be particularly recommended, and, indeed, the author has borne this section of the public in mind when preparing the course. The numerous illustrations are well drawn, and we are glad to see that the final chapter contains answers to all the exercises.

* * * * * *

"ITALIAN GRAMMAR SELF-TAUGHT." By A. C. Panagulli. London: E. Marlborough and Co. Paper wrapper, 1s. net; cloth, 1s. 6d. net. Key to Italian Grammar, 6d. net.

This little elementary work will be found very useful on account of its simplicity and brevity. The author's aim has been to eliminate that which is not absolutely essential. The grammar constructions can be easily reproduced by the pupil, numerous exercises being set on these constructions. The vocabulary is principally composed of words of frequent use and considerable stress has been laid

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on the idiomatic structure of Italian. A lucid key is published separately for the exercises contained in the Grammar. We heartily commend the work to those who wish to teach themselves Italian.

* * * * * *

"THE NEW BREED." By Andrew Firth. London: T. Fisher Unwin, Ltd. 6s.

This is a tale of love, adventure, scheming and investigation, with all the other ingredients of a good modern novel. There is more than a passing reference to wireless telegraphy, and, in fact, this science plays quite an important part in the book. Contrary to the usual practice in modern novels, there is a direct connection between the story and the title. When the hero, ascending in an aeroplane, was being watched by his mother as the great machine soared over the trees, the author says, "she recognised these young men for a new breed. They said so much less than what they meant and undertook Titanic tasks without the flicker of an eyelid."

The character of Yolande Vaughan, the spoilt Australian beauty to whom the hero has just become engaged on the opening of the book, is very cleverly drawn, and we must confess that we do not burn with indignation when her ears are boxed on page 49. However, opinions on this point will doubtless differ!

Altogether the book is an excellent one for passing away the hours off watch at sea, and we can recommend it to all who are looking for a good, interesting novel to pack in their kit-bag.

* * * * * *

"AERIAL RUSSIA: THE ROMANCE OF THE GIANT AEROPLANE." By Lieutenant-Colonel Roustam Bek. John Lane. 2s. 6d. net.

We must confess to a feeling of disappointment after the perusal of this volume. Judging by its title, we had expected to add to our knowledge of the giant Sikorsky aeroplanes, but, after careful reading, we close the book merely with a somewhat confused idea that the credit for these mighty machines must be shared equally between Sikorsky himself and a Scot, Mackenzie-Kennedy. As a series of interesting armchair chats on Russian aviation generally, however, this volume certainly makes very interesting reading. Few Englishmen are acquainted with the great strides in aerial navigation which have been made in Russia, and still fewer realise how that country has kept to the front in aviation from the very first.

The portion of the book dealing with Mr. Chessborough Mackenzie-Kennedy, who has spent many years in Russia, and to whom perhaps more than anyone else Russia owes her present position in the aeronautical world, is a story of keenness and a fight against difficulties which will make a strong appeal to all Englishmen.

It should be mentioned that the profits from the sale of this book are to be devoted to a fund for the families of British aviators who have died in the cause that is Russia's as well as theirs.

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Personal Notes

A VERY pretty wedding took place recently at All Saints' Church, Oakham, the contracting parties being Miss Edith Everlyn Geeson, daughter of Lieutenant and Mrs. G. H. Geeson, and Sergeant George Merritt Burgham, of an important wireless station engaged on Government work. A reception was subsequently held at the residence of the bride's parents, and later in the day Sergeant and Mrs. Burgham left for Weston-super-Mare, where the honeymoon was spent. On behalf of our readers we wish Sergeant and Mrs. Burgham every happiness.

* * * * * *

Another interesting wedding ceremony took place on October 2nd, at St. Michael's Church, Boldmere, Birmingham, when Mr. J. T. Marler, of the Marconi International Marine Communication Co., Ltd., was married to Miss Elsie Allen, of Hackney. Mr. Marler, who is a very popular member of the Marconi House staff, has served with the company for ten years—practically half the lifetime of the Marconi Company—and during this period has seen many changes.

After the ceremony the happy couple proceeded to Matlock for their honeymoon, which we trust proved as enjoyable as such occasions usually do. Mr. Marler's many friends among our readers will, we are sure, join with us in offering the newly married couple heartiest congratulations and best wishes for a happy married life.

* * * * * *

According to the *Lincoln Echo*, Mr. J. W. Wilson, Postmaster of Ruskington, has received notice that his son, Mr. W. B. Wilson, is interned as a prisoner of war at Affum-Kara-Hissar, in Asia Minor. He was acting as chief wireless operator on board the ill-fated *Zaida* when it was sunk in the Mediterranean. The news was received from Switzerland, through the Prisoners of War International Agency.

* * * * * *

In our September issue we referred to the award of the Croix de Guerre to Mr. Frederick Thomasson, who prior to the war was a member of the Marconi Company's staff. We are now able to reproduce a photograph of Mr. Thomasson wearing this decoration which he earned by conspicuous bravery in action.

PRIVATE FREDERICK THOMASSON.

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We have pleasure in reproducing here a photograph of Observer J. A. Hood, who prior to the war was engaged on the marine operating staff of the Marconi Company. "The Observer ignorant of wireless is no longer classed as an observer," says Mr. Hood; "he has become a back number. It stands to reason that if a British seaplane sights a hostile squadron, say 40 miles from her base or from the nearest unit of the Home Fleet, then a precious 14 minutes at least is going to be lost if the observer does not understand wireless telegraphy." Mr. Hood will have many exciting experiences to relate when the war is over.

OBSERVER J. A. HOOD.

* * * * * *

At a Scotch Tribunal recently a wireless student, who was said to be engaged all day on munition work, appealed against the refusal of his claim. In view of the fact that that was his fourth appearance, it was moved that the appeal be dismissed. The majority of the tribunal approved this, and as a consequence the claim was disallowed.

* * * * * *

Mr. J. P. Edmond, organist of Cardross Parish Church, and now serving with the Russian Legion, in a letter to a relative in Glasgow, describes his experience with the British armoured cars on their way to the fighting line. "The journey," he writes, "was one which I would not have missed for worlds. It took us through ——, and the scenery was grand and varied. The road was fairly good but full of hair-pin bends and reached to a great height (8,000 feet above sea level). We erected our wireless station at this height one night in the dark. It was very lonely and eerie, and very cold, being above the clouds."

* * * * * *

The body of a naval wireless operator named Charles Turner has been washed ashore at Charleston, on the east coast of Scotland. He was drowned through the swamping of a motor-boat.

* * * * * *

Mr. David Wyllie, Bangor, who before the war was employed at the *North Wales Chronicle* office, has been awarded the D.S.M. He is a wireless operator in the Navy.

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Company Notes

The Marconi Wireless Telegraph Company of Canada, Ltd.

ANNUAL REPORT FOR THE YEAR ENDING JANUARY 31ST, 1916.

THE Directors, in submitting their annual report and statement of accounts for the year ending January 31st, 1916, state that the company's business continues to show substantial expansion. The most gratifying feature during the year just concluded has been the steady development of the company's transatlantic traffic. In spite of the general dislocation of business created by war conditions, the work being done by the Glace Bay station in maintaining direct communication between Canada and Europe shows a satisfactory increase in traffic handled, and in income resulting from that source. There is every evidence of this improvement being maintained during the current year.

The unique value of Marconi wireless in every phase of the present war is a matter of common knowledge; its supreme value during possible isolation of any country during interruption of cable communication has been demonstrated on two occasions during the past year when the business community of Canada was to a large extent dependent on the Marconi Service between Glace Bay and Ireland.

The company's plant in Montreal has been kept fully occupied in supplying the demand for additional installations on board ships and commercial stations, as well as in meeting increased Government requirements. A growing sentiment is apparent amongst progressive shipowners that no vessel engaged in coastwise or ocean trade is fully equipped unless furnished with a Marconi wireless installation, and wireless stations aboard ship are now being viewed with favour even on vessels exempt by law from compulsory equipment. A total of some 2,300 mercantile vessels have up to the present been fitted with Marconi wireless stations by the various Marconi companies.

The directors appreciate that the goodwill of the public constitutes a most valuable asset to the company, and have accordingly extended the facilities of its marine department in order to give the best possible service to its patrons by creating divisional offices and stores in the more important centres of St. John's, Newfoundland, Toronto and Vancouver. Owing to the constant demands on the operating staff caused by the war, a school of instruction for operators has been established in Montreal under the direct control of the company, and equipped with the latest type of standard apparatus.

The adverse effect caused to the company's normal traffic to and from ships, owing to the stringency of censorship imposed on commercial messages, has unfortunately continued in evidence throughout the current period. The basis of remuneration from the Government for the use of a number of the company's coast stations taken over by the Department of Naval Service since the commencement of hostilities and for other services rendered is still under consideration, and an equitable settlement is awaited in the near future.

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The profit for the year is $110,226, as compared with $50,020 for the preceding year, and, after deducting interest on advances, the balance carried forward is $80,815, against $5,727 brought in.

Amalgamated Wireless (Australasia), Ltd.

THE sixth half-yearly ordinary general meeting was held at the registered office of the company, "Wireless House," 97, Clarence Street, Sydney, on Thursday, August 17th, 1916, at 12.30 p.m., Mr. Hugh R. Denison in the chair.

The directors' report states that trading for the period had again suffered from the continued effects of the war, and showed a falling off from the previous half-year.

With regard to ships' message traffic, notwithstanding the very stringent war regulations, the revenue from this source showed an increase, and the directors looked for still further improvement in the future.

The manufacturing department has been handicapped during the period by a shortage of skilled labour, but the work being done is of the highest class. Installations made by the company in its Australian factory have been spoken of in the highest terms by the inspecting officers of the United States Government.

Subsidy ships have increased to 90, and a further increase in this number is forecasted for next year. The company has made long contracts with most of the shipping companies.

The training school still continues its good work, and shows a small but regular profit on its working. The efficiency of the company's operators is the best test of the value of this school, as most of them have received their wireless education under its auspices.

During the half-year the company has secured the sole licence and agency for the Poulsen system of radiotelegraphy, and this should become an important adjunct to the business. The sole agency of the automatic relay telephone has also been obtained by the company.

In accordance with the Articles of Association, Mr. C. P. Bartholomew, one of the directors, retired from the board, and offered himself for re-election.

The net profit for the period under review amounted to £4,692 1s. 9d., which, with £3,331 12s. 1d. brought forward from the previous half-year, left a balance to the credit of profit and loss account of £8,023 13s. 10d.

The directors proposed to recommend a distribution of a dividend at the rate of 5 per cent. per annum on the capital of the company, absorbing £7,000, and to carry forward the balance of £1,023 13s. 10d. to the next account.

Share Market Report

LONDON, *12th October*, 1916.

BUSINESS in the Share Market has been very quiet during the past month, but there has been a fair demand for shares by small investors. The prices as we go to press are: Marconi Ordinary, £2 18s. 9d.; Marconi Preference, £2 8s. 9d.; Marconi International Marine, £2 2s. 6d.; American Marconi, 17s. 6d.; Canadian Marconi, 9s. 6d.; Spanish and General Wireless Trust, 10s. 6d.

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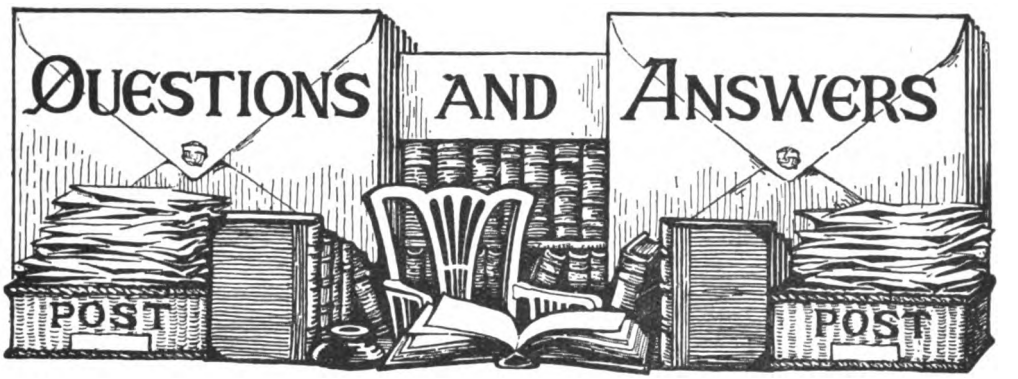

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, ***Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.***

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

P. R. (Wireless Station, Peshawar) (1) states that the following formula is quoted, in a pamphlet on wireless, for the voltage to which the condenser is charged by the secondary transformer circuit

$$E_c = \frac{\pi}{2}\sqrt{\cdot 80}\sqrt{2}\, E_s$$

E_c being the condenser voltage, and E_s the virtual voltage of the secondary. He inquires what the factor $\sqrt{\cdot 80}$ represents. (2) When using a Marconi 30-kw. 350-cycle set to transmit short waves, he notices a flaming at the spark-gap, which cannot be got rid of by any adjustment of the low-frequency tuning inductance or adjustment of the phase position of the spark discharger.

Answer.—The theoretical formula for the condenser charging voltage is that given by you without the factor $\sqrt{\cdot 80}$. This, however, implies that the ratio of the voltages of the transformer is constant under all conditions of load, so that the factor $\sqrt{\cdot 80}$ is probably intended to correct for the fact that in the actual transformer in use this does not hold, the secondary volts being lower in consequence. It is written in the square-root form as a matter of convenience, since for a transformer the relationships between the two circuits often involve the square of the various quantities, such as inductance, etc. (2) The flaming at the gap is probably due to insufficient low-frequency inductance, since you state you are using all that has been provided. This transformer, being designed primarily to work with a large capacity, would require more inductance when charging the small capacity used for short waves. (3) We do not know of any book in which the transformer is treated of fully, showing vector diagrams of the relative effects of capacity, etc., in the two circuits as referred to in Mr. Hallboy's paper. This is, of course, a fairly recent application of the transformer, and the discussion does not yet appear to have found its way into the text-books. A short article, by L. B. Turner, appeared in the *Electrician*, August, 1912, and is quoted in Dr. Eccles' "Handbook."

F. W. G. (H.M.S. ——).—The article in the Proceedings of the Institute of Radio Engineers to which you refer will, we think, give you all the information you require.

H. L. (Bradford).—A wireless operator in the Marconi Company is required to provide his own uniform. When a candidate is accepted for the Marconi Company's school for completion of training, he is not required to pay any fee. On the contrary, he is paid a salary during training dependent upon the extent of his knowledge when he enters. The duration of his stay in the school also depends upon the extent of his knowledge. We shall be pleased to give you any other information you require on this subject.

P. G. (London).—Particulars of conditions of employment and rates of pay can be obtained on application to The Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C. See answer to H. L. (Bradford).

INTERFERENCE (Margate).—It is quite possible to work a sensitive wireless receiving station in a building containing electric lifts, motors, lights, bells, etc., provided suitable precautions are taken. Modern passenger liners such as the *Olympic*, *Aquitania*, etc.,

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contain hundreds of electrical devices such as those mentioned by you, and no trouble is experienced. The whole of the low frequency wiring of the Marconi installation is lead covered, the covering being earthed. This is a very effective means of preventing interference from the sparking of auxiliary electrical apparatus.

R. S. T. (Queen's Park, W.A.).—(1) The armature of the magnetic key is drawn down and released at the frequency, which is the same as that of the alternating current which passes through the coils of the magnet. If a low frequency alternating current is passed through a telephone receiver, the diaphragm will be drawn towards the magnets and released in exactly the same way, giving a hum which depends on the frequency. It is only when the frequency is much higher than that at which it is possible for the diaphragm to vibrate that alternating current will not operate the telephone receiver. (2) We are afraid we cannot give you any information on your second question unless you inform us of the type of rotary converter to which you refer.

H. E. P. (Leicester).—(1) Marconi Operators are not bound by their agreement to serve for any definite period, although of course it is expected that a man will not enter the wireless service with the intention of leaving it after a short period. Question 2 is answered in Question 1. (3) Wireless operating has no injurious effect whatever upon the operator's health; on the contrary, most men benefit considerably by taking up this profession, as it enables them to get the benefit of the sea air. (4) As you say you can send and receive at 20 words a minute, we would suggest that you should apply to The Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C., stating your qualifications and asking if there is any vacancy which can be offered you. (5) The agreement can be terminated by one month's notice. (6) No.

C. H. P. (Harrogate).—There is no premium to pay for becoming a wireless operator in the Marconi Company. (2) Yes. (3) The cost of becoming a wireless operator after the P.M.G. certificate is obtained is very little. If a candidate is otherwise suitable, he will probably be able to obtain employment in the Marconi Company immediately upon obtaining his Postmaster-General's Certificate, provided, of course, there is a vacancy at the time. In this case as soon as the man is accepted he will be paid a salary, and practically the only expenses he will be put to are the cost of living while he is finishing his training in London, the fee to the doctor for medical examination and the cost of his uniform and outfit.

E. E. S. C. (Manchester).—(1) *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett. (2) Yes, the same amount of knowledge can be obtained by attending evening classes as by day classes, but naturally it will take longer to learn in the evening classes as these are shorter than those of the day. (3) Some of the back numbers of THE WIRELESS WORLD are still obtainable and some are not. If you will send a list of the back numbers you require, we will inform you which of them are still obtainable. (4) The new volume of THE WIRELESS WORLD commences in April. There are twelve numbers to each volume, and volume 1 opened in April, 1913. (5) The school you mention is not controlled by the Marconi Company and is a private institution. It is, however, fully equipped with the necessary apparatus for training wireless operators. (6) Yes.

P. R. (County Wexford).—The address of the Postmaster-General is General Post Office, London. (2) You should be able to obtain a good style of sending by copying the signals of the Marconi Official Records on the key connected to a buzzer.

H. C. K. (Tottenham).—(1) The angle should be *minus* 135° or *plus* 225°. This is seen much more readily by the diagram on page 144 than by your calculations. You will always find it a great help to draw out these problems roughly, even when solving by calculation. (2) This point should be quite clear from Article 7 in the March number of THE WIRELESS WORLD.

H. M. (Barrow-in-Furness).—The statements made are not correct with regard to the Marconi Company. There is no rule that a man away from a home port for three months or more receives extra pay. In certain cases of *foreign* service additional salary is paid, however. Did the school in question give the particulars you mention as applying to the Marconi Company?

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Lady Operators at Work

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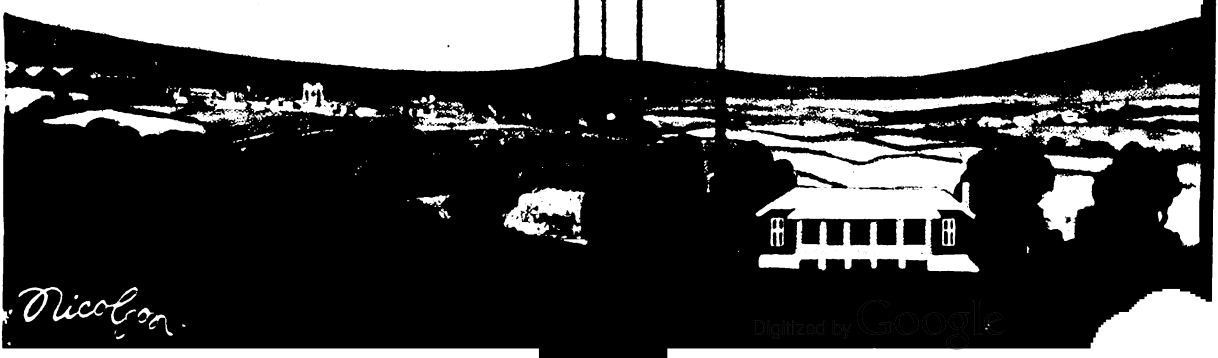

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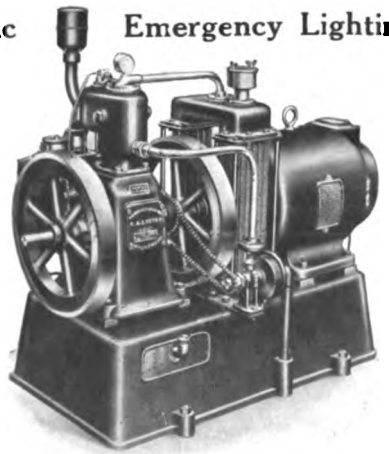

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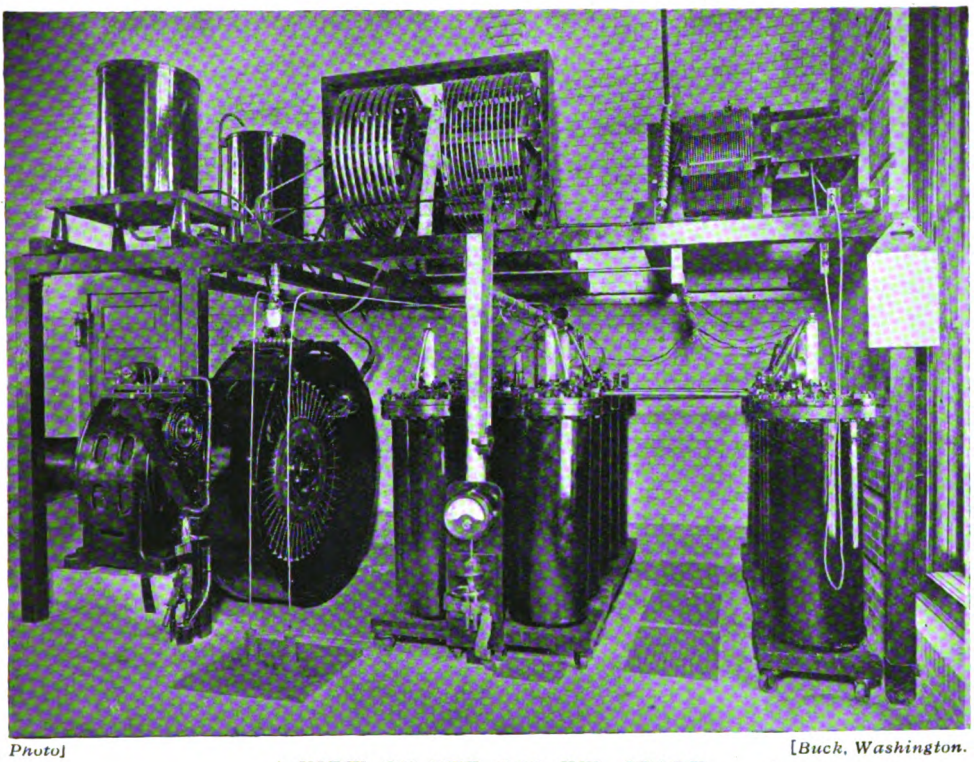

Photo] [*Buck, Washington.*

A VIEW OF THE 100-KW. SPARK TRANSMITTER AT WASHINGTON RADIO.

The United States Radio Station at Arlington

Its Erection and Equipment

FEW wireless men are unacquainted with the name of the giant radio station at Arlington, now known as "Washington Radio," and thousands of amateur and professional operators listen each day to its time signals and news service. The following particulars of the equipment of the station and the photos which we are able to reproduce will, we are sure, be welcomed by the many wireless enthusiasts in this country.

Before the present site was finally selected a number of others in the vicinity of Washington were carefully examined. In erecting a large wireless station it is necessary to see that the ground is suitable for a good wireless "earth," whilst the surrounding country has to be such that there will be a minimum of absorption of electro-magnetic waves by mountains or buildings in the immediate vicinity. Certain military considerations have also to be taken into account in order that the station may be adequately protected from a possible invader. The site finally chosen was

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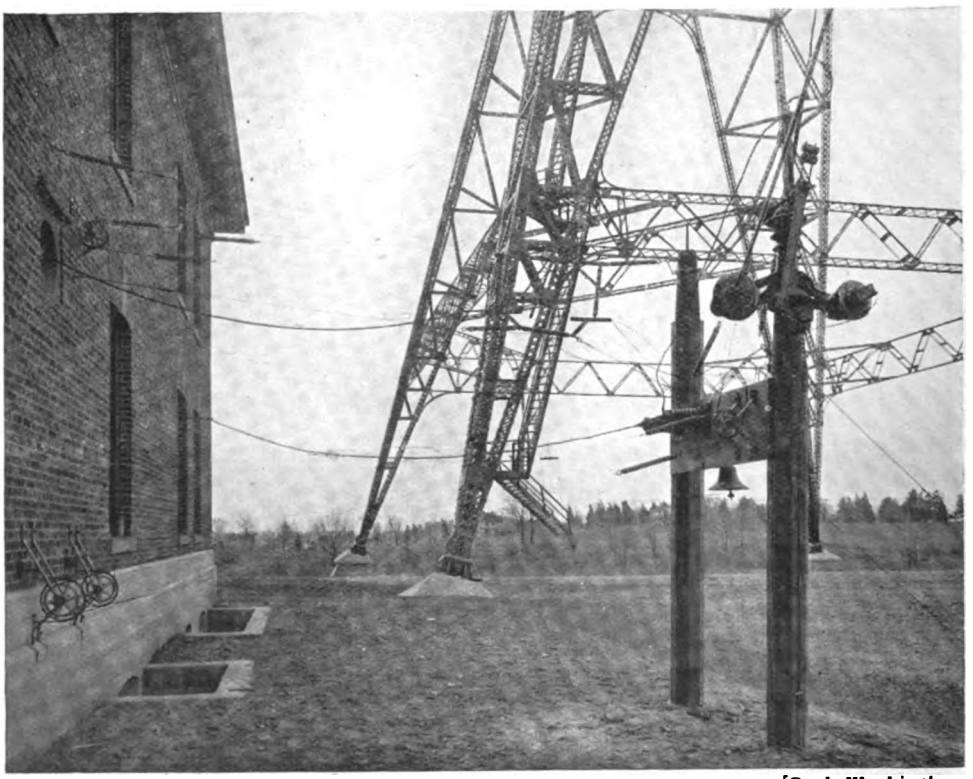
formerly part of what was known as the Fort Myer Military Reservation, and the ground, roughly 13½ acres in extent, was transferred to the Navy Department by Act of Congress.

In our large illustration we are able to give an excellent view of the three skeleton steel towers, one of which (that in the centre of the illustration) reaches a height of 600 feet. The other two are 450 feet high. The centres of the towers form an isosceles triangle, the base of the triangle being 350 feet long. The metalwork of the great structures is insulated from the ground, but switches are provided on each leg so that the towers may be "earthed" when required; 275 tons of steel were used in the construction of each of the smaller towers, and no less than 500 tons in the larger. The steel was furnished by the Carnegie Steel Company, and the erection undertaken by the Baltimore Bridge Company.

Three-phase 25-cycle alternating current is supplied to the station from the mains at 6,600 volts. It is then stepped down to 220 volts, and led to the wireless transmitter, of which there are three. The first is a 100-kw. spark set of the Fessenden system, the second a 5-kw. spark set manufactured by the Wireless Improvement Company, the third a 100-kw. Poulsen continuous wave plant.

The 100-kw. spark set, which is admirably shown in our illustrations, is very



Photo] [*Buck, Washington.*

THE AERIAL SWITCH AND LEADING-IN WIRES. THIS PHOTOGRAPH WILL HELP THE READER TO REALISE THE IMMENSITY OF THE STEEL MASTS.

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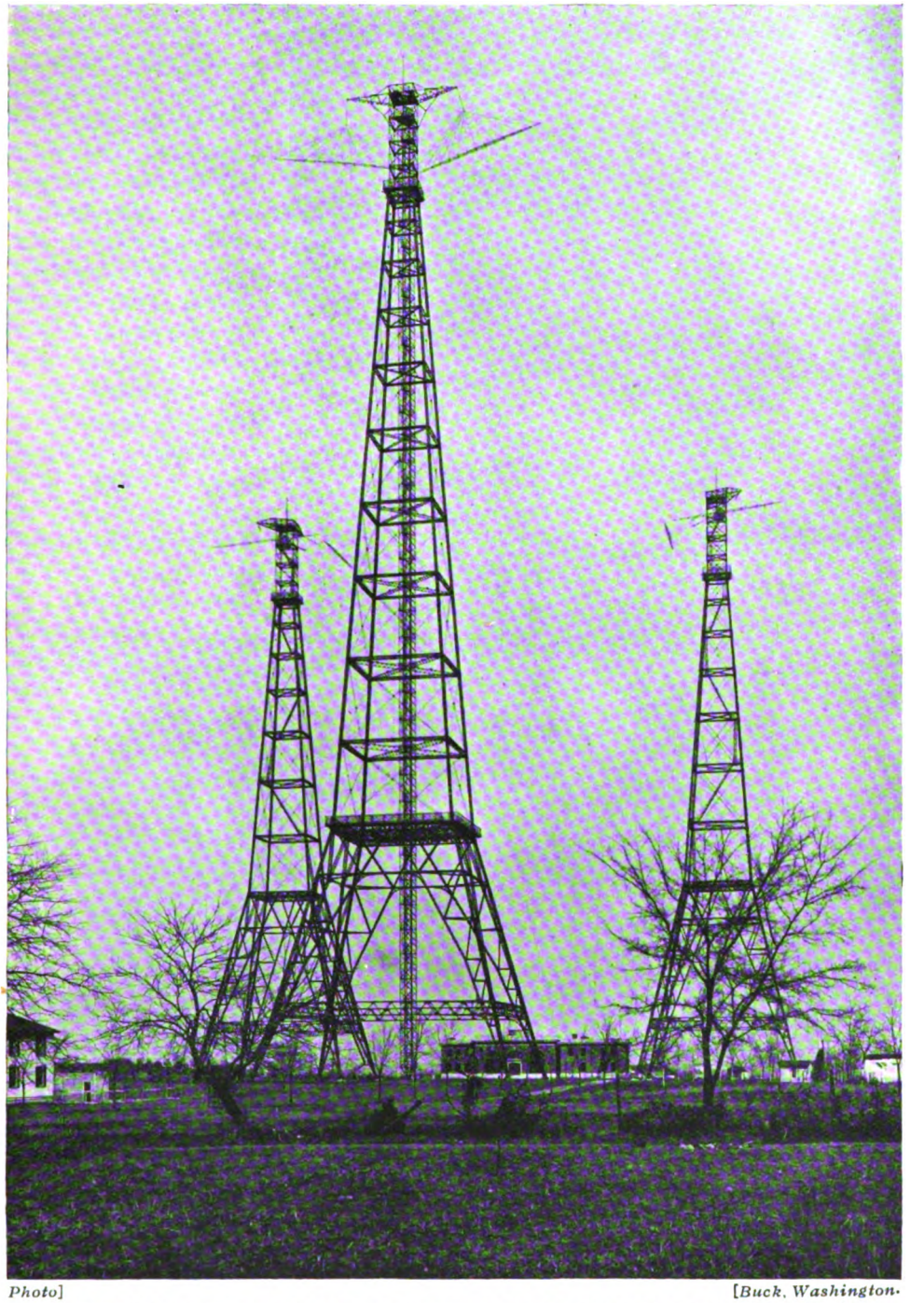

Photo] *[Buck, Washington.*

A VIEW OF THE THREE GIANT TOWERS AT THE WASHINGTON (ARLINGTON) RADIO STATION. THE NEAREST STRUCTURE IS 600 FEET HIGH.

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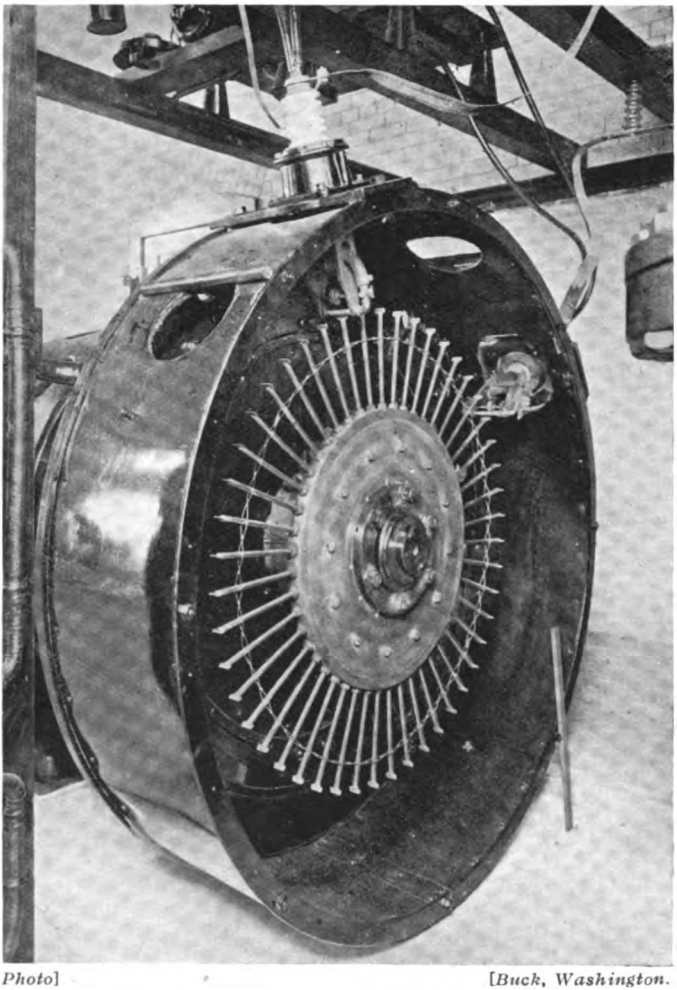

Photo] *[Buck, Washington.*

THE ROTARY DISCHARGER. THE STATIONARY ELECTRODES ARE WATER-COOLED.

similar in general design to a Marconi set, and, in fact, utilises several important Marconi patents. The illustration on page 661 shows the general arrangement of the apparatus, the alternator and rotary spark-gap being shown on the left, the condenser banks in the centre and right-hand side, and the primary and secondary of the jigger on the framework above. The transformer is situated underneath the floor, and the high - tension leads can clearly be seen.

Dealing now in detail with this set, we find that the main driving unit is a Westinghouse 200 h.p. 220 volt 25 cycle 3-phase synchronous motor, running at 300 revolutions per minute, and controlled by means of an oil switch with autostarter. On this motor shaft, and driven by it, is an 8-kw. 110 volt direct current generator which is used to excite the fields of both the 200 h.p. driving motor and the 100-kw. generator which furnishes the energy for the transmitting apparatus. The synchronous motor and 8-kw. generator are not shown in this photograph. The 100-kw. generator (on the left of the illustration) was built by the General Electric Company, and furnishes current at 220 volts, 500 cycles. It runs at 1,250 revolutions per minute, and is driven through a leather belt, just visible on the borders of the picture, from the 200 h.p. motor. The rotary spark-gap, shown in detail on this page, is attached to the framework of the generator, the rotary portion being bolted to the generator shaft. The gap is a synchronous one, and the rotor consists of a fibre wheel with a heavy brass ring on its outer circumference, from

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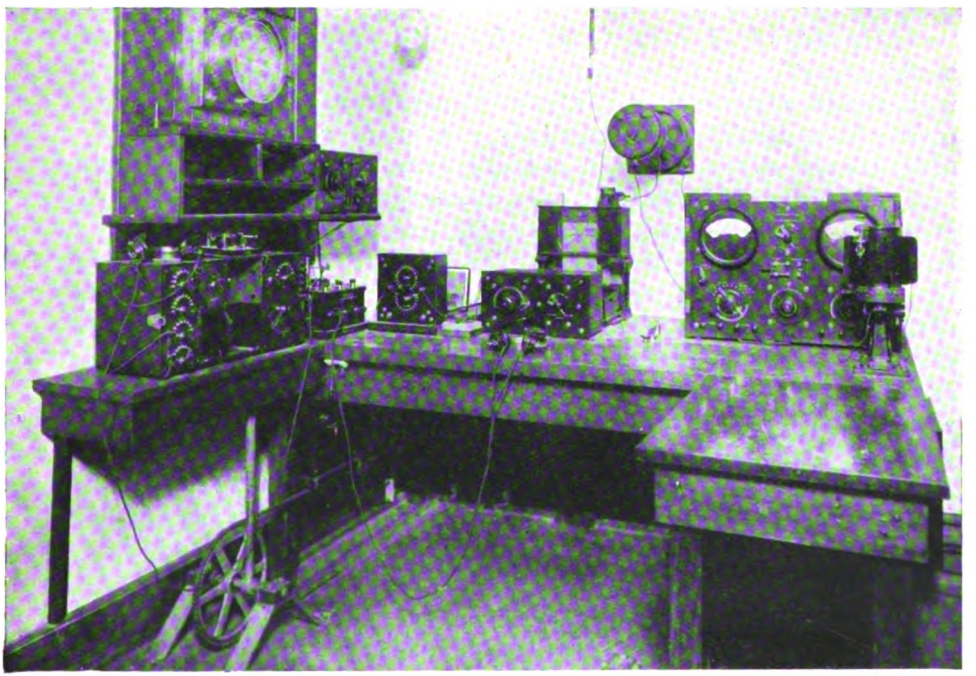
which protrude 48 copper electrodes, each about 10 inches long. The casing of the rotor which carries the stationary electrodes is fitted so that it can be moved backwards and forwards by a worm gear. Water is circulated through the stationary electrodes from the tank, which can be seen on the staging above. The small taps for controlling water supply are well seen in the large illustration. Phase adjustment with the spark-gap is made by slightly rotating the casing. The main leads of the generator run to a panel on the switchboard, and after passing through a circuit breaker one lead runs to the primary of the transformer and the other to a large relay key. The action of this key can be well seen from the wiring diagram on page 666. Shunted around the relay contacts is a large variable resistance grid which carries a large proportion of the current running to the primary. When the operating key is closed the relay cuts out this resistance, and the spark is made. When the key is opened, instead of the whole current being broken at the relay contacts, a great proportion of it runs through the resistance, and thus excessive sparking and wear on the relay contacts is avoided. The relay itself is worked from a small sending key, which is shown upon the table in the illustration on this page. The secondary leads carry current from the transformer to the stationary electrodes, across which are shunted the condensers and primary inductance of the jigger. The primary inductance is a helix made of eight turns of 1-inch copper tubing about 4 feet in diameter, fitted with suitable spring clips, by means of which the leads can be clamped to any turn for varying the sending wave-length. The condensers



Photo] [Buck, Washington.

THE OPERATING ROOM AT WASHINGTON RADIO. THE TRANSMITTING KEY CAN BE SEEN ON THE RIGHT OF THE CENTRAL RECEIVING APPARATUS.

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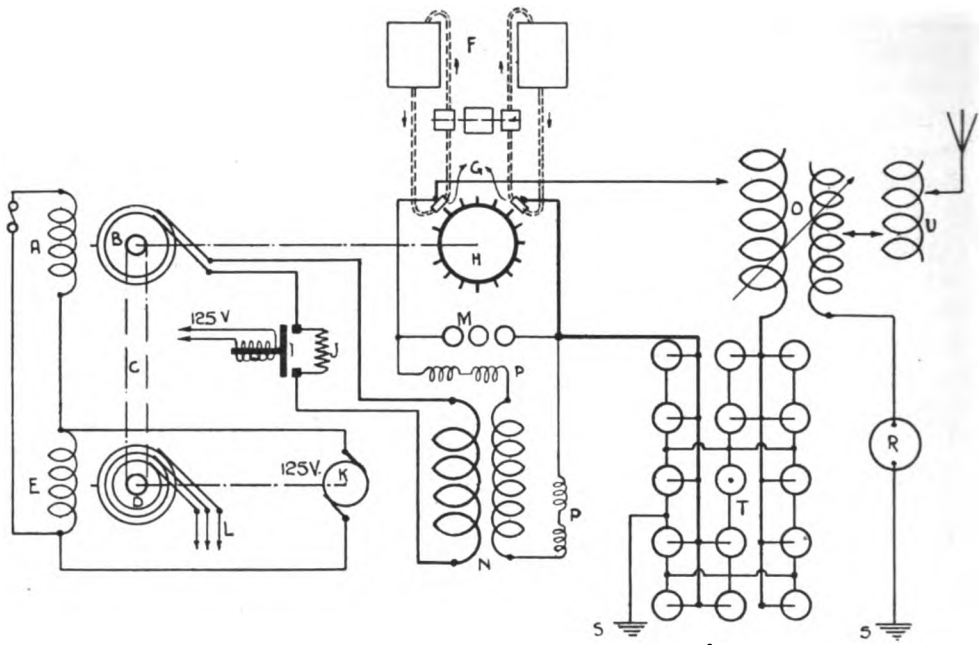

WIRING DIAGRAM OF THE 100-KW. SPARK TRANSMITTER AT WASHINGTON RADIO.

are of the compressed-air type, and each consists of a large cylindrical metal tank, in which about 200 plates are suspended. One set of plates is connected to the tank itself, and the other to a rod which runs through an insulator in the centre of each cover. These insulators can be clearly seen in the photograph. A lead washer under the rim of the cover and a lead bushing around the insulator ensure the tank being airtight. The plates are placed one-eighth of an inch apart and, of course, at that distance would not be able to withstand high voltage were it not for the compressed air. After the condenser has been assembled the air is compressed to a pressure of 250 lbs. per square inch. A safety gap is then set on the outside of the tanks between the rod through the insulator and a terminal on the tank cover, this gap being slightly longer than the distance between the plates. The primary current is then turned on intermittently, allowing sparking to take place inside, until the small particles of dust in the air are burned out, after which the spark will jump across the safety gap. The latter is then lengthened, and the operation continued until the safety gap is enlarged one inch. By this treatment a spark can be made to jump a 1-inch gap in air before it will traverse the one-eighth inch in compressed air. Each condenser has a capacity of 0.036 microfarad, the fourteen units being placed two sets of seven in parallel and two sets in series.

The secondary of the oscillation transformer is made up in the same manner as the primary, but of three-eighths inch copper tubing with twice the number of turns. One lead is led to the hot-wire ammeter (shown in the photograph) and thence to the ground, and the other to a spring clip which can be connected to any turn of the aerial-tuning inductance (shown in the top right-hand corner). The adjustment

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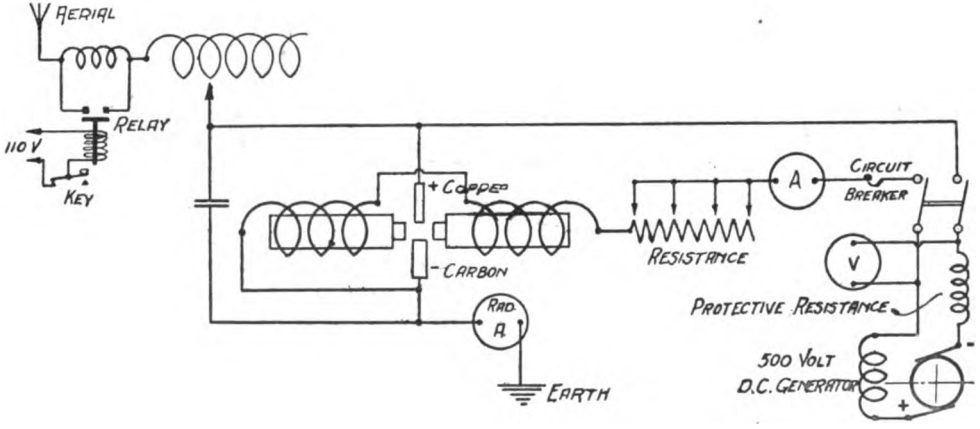
of the oscillation transformer is made as nearly correct as possible before the spark is turned on, and then the aerial-tuning inductance, which has a sliding contact, can be revolved while the spark is in operation by means of the cord and pulleys seen on the right-hand side of the illustration. By watching the hot-wire ammeter and observing when the highest reading is obtained, it is easy to see when the aerial is in resonance with the primary. The aerial lead is taken from the aerial-tuning inductance through an insulator fitted in a plate-glass window, 1 inch thick and 5 inches square, to a switch arrangement on short wooden poles, shown on the right-hand side of the photograph on page 662.

The aerial is made up of three sections, 23 wires in each section, each wire consisting of seven strands of No. 20 phosphor bronze. These wires are attached to spreaders 88 feet long, the spreaders themselves being attached to the towers by 10 electrose insulators. The aerial is open at the highest end (at the 600-feet tower), and two sections are brought down to the 450-feet towers, and two joined to the main section by " jumpers " made up of 23 wires bunched in the form of a rope. The main section is what is known as a " T " antenna, and the vertical part is taken from the middle. The 23 wires are brought down in the shape of a fan for 300 feet, and then in the form of a large cage the rest of the way to the switch on the tall mast.

The ground connections consist of many lengths of wire buried in the ground at various depths in the space near the towers, and led in a " draught-board " pattern with soldered junctions. Many miles of wire were laid in making the large network, and, finally, wire leads were run down the slopes ending in a small stream that flows near by. The ground connection between the aerial and this network is through a large copper strip 6 inches wide and a quarter-inch thick.

For the description of the Arlington Station, above given, we have drawn freely from a paper presented to the Washington section of the Institute of Radio Engineers, by Capt. William H. G. Bullard, U.S.N., until recently Superintendent of the United States Naval Radio Service. Capt. Bullard's paper is reproduced in full in the Proceedings of the Institute of Radio Engineers, to the Editor of which we are indebted for permission to utilise the information therein contained.



WIRING DIAGRAM OF THE 100-KW. ARC TRANSMITTER AT WASHINGTON RADIO.

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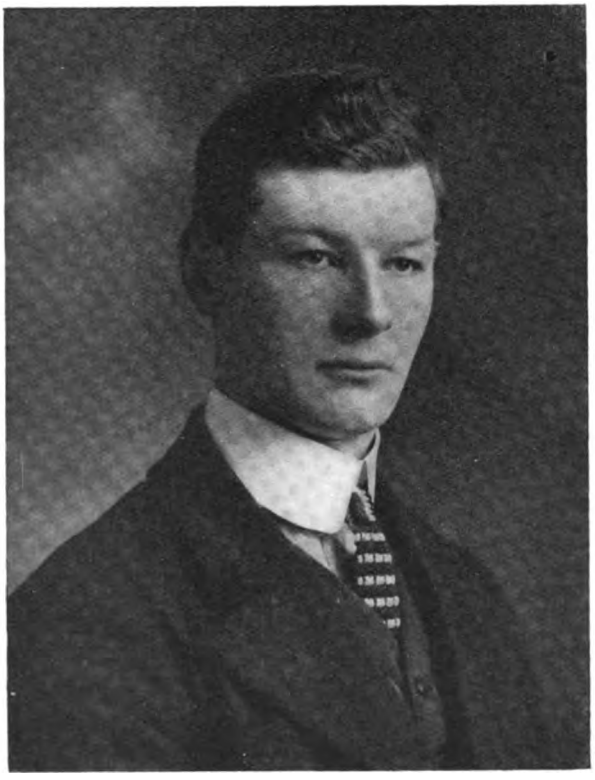
PERSONALITIES IN THE WIRELESS WORLD



Mr. N. W. McLACHLAN, B.Sc., A.M.I.E.E.

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THE subject of our Biography, Mr. Norman W. McLachlan, was born at Long Town, Cumberland, on July 26th, 1888. He received his secondary education at Carlisle Grammar School, where he won a scholarship, and at the George Watson's College, Edinburgh. Entering the Heriot-Watt College at Edinburgh for a technical training, he soon distinguished himself, and at the age of eighteen stood first in the final year in electrical engineering, physics, and mathematics with unusually high marks. Before leaving this institution the brilliant young scholar had been awarded a diploma in electrical engineering and five medals. It was Mr. McLachlan's first intention to enter a manufacturing firm as an engineer, but he was soon attracted to the teaching profession, and in 1909 went to Newcastle-on-Tyne as a lecturer in engineering and mathematics.

In 1912 Mr. McLachlan graduated B.Sc. (Engineering), and in 1913 he was appointed superintendent to a branch technical institute and supervisor of classes in engineering subjects in the Liverpool branch Technical Institutes. For the past two years Mr. McLachlan has been carrying out research work in his spare time in the Applied Electricity Laboratories of the Liverpool University. As an author Mr. McLachlan has written *Practical Mathematics* (Longmans & Co.) and published several papers in the *Journal of the Institution of Electrical Engineers* and the *Electrician* on "The Magnetic Behaviour of Iron." In 1915 he read a paper and performed experiments before the Engineering Section of the British Association at Manchester on "The Heating of Iron when Magnetised at High Frequencies." His paper before this year's British Association meeting was reprinted in part in last month's WIRELESS WORLD, and is continued in the present issue.

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The Accurate Calculation of the Inductance of Single Layer, Air Core Solenoids; Simplified by means of Tables

By BERTRAM HOYLE, M.Sc.Tech., A.M.I.E.E.,
Lieut. R.N.V.R., H.M.S. *Excellent.*

THERE are numerous formulæ available for different types of coils, but the limitations of each particular formula are not always made clear. At the best, these formulæ, when found, are cumbersome, and not easy to work out without practice. The object of the present article is to give tables of the more difficult functions calculated for the limits within which they can be accurately applied. The tables are given for all ratios of coil radius to coil breadth, likely to be encountered in receiver of transmitter primary or secondary coils in wireless stations.

The two formulæ which are discussed, and for which tables of the functions Q and X are given, are:

Lorenz's equation $Ls = an^2Q$ . . . . . (1)

and Rayleigh's equation $Ls = 4\pi an^2X$ . . . . . (2)

where Q and X are functions of the ratio $\frac{a}{b}$; the ratio of the radius of coil to coil breadth.

SYMBOLS USED.

a = radius of centre line of turns in cms.
b = breadth overall, of coil in cms.
d = diameter of conductor in cms.
D = diameter over insulation in cms.
f = frequency, in cycles per sec.
n = total number of turns on coil.
K = capacity in micro-farads.
Ls = the inductance of the coil on the assumption that the current flows in a cylindrical sheet.
L = true inductance = $Ls - \Delta L$.
ΔL = a correcting factor for thickness of insulation and number of turns.
M = mutual inductance.
A and B = correcting terms for ΔL. See Tables.
Q and X = functions explained in context, and tabulated at the end.
ρ = radius of conductor.
λ = wave-length in metres.

Formula (1)—$Ls = an^2Q$.

Q is a complicated function involving elliptic integrals, and has for value

$$Q = \left[\frac{8\pi}{3}\left\{\sqrt{1+\frac{b^2}{4a^2}\left(\frac{4a^2}{b}-1\right)}E+\sqrt{1+\frac{b^2}{4a^2}}F-\frac{4a^2}{b}\right\}\right]$$

E and F being the elliptic integrals.

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Values of Q are tabulated for $\frac{2a}{b}=0{\cdot}20$ to $3{\cdot}00$, whilst X is tabulated for values of $\frac{a}{b}$ from 1 to 55.

The limits given for $\frac{a}{b}$ embrace all cylindrical coils, or parts of coils, likely to be required in wireless telegraphy, that is from coils whose breadth (or axial length) b is ten times their radius a, to those whose breadth b is only $\frac{1}{5}\frac{1}{5}$th their radius a.

Thus where $n=4$

$$Ls=4L_1+6M_{12}+4M_{13}+2M_{14}.$$

The values of L_1 and M are worked out by the formulæ of Rayleigh and Niven

$$Ls=4\pi a\left\{\left(1-\frac{\rho^2}{8a^2}\right)\log_\epsilon\frac{8a}{\rho}+\frac{\rho^2}{24a^2}-1{\cdot}75\right\} \quad . \quad . \quad . \quad (3)$$

$$M=4\pi a\left\{\log_\epsilon\frac{8a}{d}\left(1+\frac{3d^2}{16a^2}\right)-\left(2+\frac{d^2}{16a^2}\right)\right\} \quad . \quad . \quad . \quad (4)$$

This summation formula is very cumbersome, and especially so where n is greater than ten turns.

It is pointed out here, because an example of the exactness of the complete general formula is given in comparison with the summation method.

In formula (2) $Ls=4\pi an^2X$, the value of X is

$$\left\{\log_\epsilon\frac{8a}{b}+\frac{b^2}{32a^2}\left(\log_\epsilon\frac{8}{ab}+0{\cdot}25\right)-0{\cdot}5\right\}.$$

which gives Rayleigh's complete general formula

$$Ls=4\pi an^2\left\{\log_\epsilon\frac{8a}{b}+\frac{b^2}{32a^2}\left(\log_\epsilon\frac{8a}{b}+0{\cdot}25\right)-0{\cdot}5\right\}.$$

It must be pointed out here that whereas (1) and (2) need corrections applying; the summation formula does not, and it will be seen that the number of turns and their spacing apart is taken into account in that case as the work proceeds.

The correction formula for (1) and (2) is

$$\Delta L=4\pi an\,(A+B)$$

and the true inductance is

$$L=Ls-\Delta L.$$

NOTE.—ΔL may be positive or negative.

The functions A and B are tabulated,

A being the correction for insulation space, whether air or solid.

B being the function depending on n, the number of turns.

Ls is the inductance that the coil would have if the current flowed in a cylindrical sheet of breadth b and radius a, and of no thickness.

Where L_1. is the inductance of a single turn (formula 3),

and $M_{1\cdot2}$. is the mutual inductance between turns separated by 1. $M_{1\cdot3}$. is the mutual inductance between turns separated by 2, and so on; the values of M being obtained by formula 4.

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Thus in the example given $6M_{1\cdot2}$. stands for:

(*a*) The mutual inductance of turn 1 on turn 2.
(*b*) The mutual inductance of turn 2 on 1 and on 3.
(*c*) The mutual inductance of turn 3 on 2 and 4.
(*d*) The mutual inductance of turn 4 on turn 3.

These summed up give six times the mutual inductance of two adjacent turns.

Similarly, it will be seen that $4M_{1\cdot3}$. stands for the mutual inductance of turns situated next but one to one another and so on.

EXAMPLE OF ACCURACY OF (2) COMPARED WITH THE SUMMATION METHOD.

(*Abstracted from Bulletin of Bureau of Standards, Washington, Vol. II., No. 1.*)

DATA.—$a=25$ cm., $b=1$ cm., $n=10$, $\rho=0{\cdot}040$ cm., $d=0{\cdot}080$ cm., $D=0{\cdot}100$ cm.

Working out formula (3) once and (4) nine times for these values, the following is obtained, π being left out for clearness and simplicity.

$10\times L_1.$	=	$6767{\cdot}196\times\pi$ cms.
$18\times M_{1\cdot2}.$	=	$10081{\cdot}664\times\pi$ cms.
$16\times M_{1\cdot3}.$	=	$7852{\cdot}535\times\pi$ cms.
$14\times M_{1\cdot4}.$	=	$6303{\cdot}439\times\pi$ cms.
$12\times M_{1\cdot5}.$	=	$5057{\cdot}868\times\pi$ cms.
$10\times M_{1\cdot6}.$	=	$3991{\cdot}888\times\pi$ cms.
$8\times M_{1\cdot7}.$	=	$3047{\cdot}787\times\pi$ cms.
$6\times M_{1\cdot8}.$	=	$2193{\cdot}465\times\pi$ cms.
$4\times M_{1\cdot9}.$	=	$1408{\cdot}982\times\pi$ cms.
$2\times M_{1\cdot10}.$	=	$680{\cdot}982\times\pi$ cms.
	By summation	$47385{\cdot}80\times\pi$ cms.

Working out formula (2) to the highest number of decimal places, the result is

$$Ls=4\pi\times25\times100\left\{\log_\epsilon 200+\tfrac{1}{20,000}(\log_\epsilon 200+0{\cdot}25)-0{\cdot}5\right\}.$$

$$=47{,}985{\cdot}77\times\pi \text{ cms.}$$

$$\Delta L=1000\pi\,(0{\cdot}3337+0{\cdot}2664)$$

$$=600{\cdot}1\ \pi$$

True L by this method $=Ls-\Delta L$ is

$$47385{\cdot}67\times\pi \text{ cms.}$$

The difference being quite within the limits of possible accumulation of errors in working out equations (3) and (4).

There are limitations to be observed in using formulæ (1) and (2), and the tables of Q and X given overlap somewhat in giving values of Q and X for equal ratios of $\frac{a}{b}$.

The following example will make clear the use of all the tables, and give a comparison of the results by each method (1) and (2).

Example.—Showing the working of both (1) and (2) and a comparison of the results.

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Let $\frac{a}{b}=1{\cdot}25$ $\qquad n=100$

$a=12{\cdot}5$ cms. $\qquad d=0{\cdot}075$ cms.

$D=0{\cdot}10$ cms.

Using (1) $Ls = a, n^2, Q.$

$=12{\cdot}50\times 10{,}000\times 23{\cdot}288$

$=2{,}911{,}000$ cms.

Correction $\Delta L = 4\pi an\,(A+B)$

A for $\frac{d}{D}=0{\cdot}75$ is $0{\cdot}2691$

B for $n = 100$ is $0{\cdot}3280$

$\therefore\ A+B$ is $0{\cdot}5971$

$\Delta L = 4\pi\times 12{\cdot}5\times 100\ (0{\cdot}5971).$

$=9379$ say $9380.$

True L $=2{,}901{,}620$ cms. say.

Same example worked out by formula (2):

$Ls=4\pi an^2X$, where X is $1{\cdot}854$ from the table for $\frac{a}{b}=1{\cdot}25$ by interpolation between $1{\cdot}2$ and $1{\cdot}3$.

$Ls=4\pi\times 12{\cdot}5\times 10{,}000\times 1{\cdot}854.$

$=2{,}911{,}700$ cms.

The same correction gives—9379, say—9380.

Whence true $L=2{,}902{,}320$ cms.

The difference of 700 cms. is equivalent to approximately 1 in 4300; which is quite as accurate as the accompanying tables are intended to be.

For all practical purposes the tables are given to fourth-figure accuracy.

NOTES.

The formulæ for inductance given above all evaluate L in cms.; the relation of the centimetre units to the henry, and its sub-multiples is as follows:

1 henry $=10^9$ cms.
1 milli-henry $=10^6$ cms.
1 micro-henry $=10^3$ cms.

The wave-length and frequency formulæ in wireless telegraphy become

$\lambda=59{\cdot}6\sqrt{L.K.}$ often taken as

$=60\ \sqrt{L.K.}$ = wave length in metres.

and $f=\frac{5{\cdot}033\times 10^6}{\sqrt{L.K.}}$ often taken as

$=\frac{5{,}000{,}000}{\sqrt{L.K.}}$ the frequency in cycles per second

[*Continued at bottom of page 675.*

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TABLE OF FUNCTION Q.

$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q	$\frac{2a}{b}$	Q
0·20	3·632	0·90	12·631	1·60	18·304	2·30	22·324
0·21	3·797	0·91	12·729	1·61	18·373	2·31	22·374
0·22	3·961	0·92	12·828	1·62	18·442	2·32	22·423
0·23	4·125	0·93	12·924	1·63	18·501	2·33	22·473
0·24	4·289	0·94	13·021	1·64	18·578	2·34	22·522
0·25	4·452	0·95	13·116	1·65	18·645	2·35	22·571
0·26	4·614	0·96	13·212	1·66	18·711	2·36	22·620
0·27	4·773	0·97	13·306	1·67	18·777	2·37	22·669
0·28	4·929	0·98	13·401	1·68	18·842	2·38	22·718
0·29	5·082	0·99	13·495	1·69	18·906	2·39	22·767
0·30	5·234	1·00	13·589	1·70	18·969	2·40	22·815
0·31	5·385	1·01	13·682	1·71	19·032	2·41	22·863
0·32	5·535	1·02	13·775	1·72	19·094	2·42	22·911
0·33	5·684	1·03	13·877	1·73	19·156	2·43	22·958
0·34	5·832	1·04	13·959	1·74	19·218	2·44	23·006
0·35	5·980	1·05	14·049	1·75	19·279	2·45	23·053
0·36	6·127	1·06	14·140	1·76	19·339	2·46	23·101
0·37	6·274	1·07	14·230	1·77	19·399	2·47	23·148
0·38	6·420	1·08	14·319	1·78	19·459	2·48	23·195
0·39	6·564	1·09	14·407	1·79	19·519	2·49	23·242
0·40	6·710	1·10	14·496	1·80	19·579	2·50	23·288
0·41	6·852	1·11	14·583	1·81	19·639	2·51	23·335
0·42	6·995	1·12	14·671	1·82	19·699	2·52	23·380
0·43	7·135	1·13	14·757	1·83	19·758	2·53	23·426
0·44	7·273	1·14	14·843	1·84	19·818	2·54	23·471
0·45	7·409	1·15	14·927	1·85	19·877	2·55	23·516
0·46	7·544	1·16	15·012	1·86	19·936	2·56	23·561
0·47	7·678	1·17	15·094	1·87	19·995	2·57	23·606
0·48	7·811	1·18	15·177	1·88	20·054	2·58	23·651
0·49	7·943	1·19	15·258	1·89	20·113	2·59	23·696
0·50	8·075	1·20	15·338	1·90	20·174	2·60	23·740
0·51	8·205	1·21	15·418	1·91	20·233	2·61	23·784
0·52	8·335	1·22	15·498	1·92	20·289	2·62	23·828
0·53	8·464	1·23	15·578	1·93	20·347	2·63	23·872
0·54	8·593	1·24	15·657	1·94	20·405	2·64	23·916
0·55	8·721	1·25	15·736	1·95	20·463	2·65	23·960
0·56	8·848	1·26	15·815	1·96	20·520	2·66	24·004
0·57	8·974	1·27	15·894	1·97	20·577	2·67	24·048
0·58	9·098	1·28	15·972	1·98	20·634	2·68	24·091
0·59	9·219	1·29	16·050	1·99	20·690	2·69	24·135
0·60	9·339	1·30	16·128	2·00	20·746	2·70	24·178
0·61	9·460	1·31	16·205	2·01	20·802	2·71	24·221
0·62	9·581	1·32	16·283	2·02	20·858	2·72	24·265
0·63	9·701	1·33	16·360	2·03	20·914	2·73	24·308
0·64	9·820	1·34	16·437	2·04	20·969	2·74	24·351
0·65	9·938	1·35	16·514	2·05	21·024	2·75	24·393
0·66	10·056	1·36	16·591	2·06	21·079	2·76	24·436
0·67	10·173	1·37	16·668	2·07	21·134	2·77	24·478
0·68	10·289	1·38	16·745	2·08	21·189	2·78	24·521
0·69	10·403	1·39	16·821	2·09	21·243	2·79	24·563
0·70	10·514	1·40	16·898	2·10	21·298	2·80	24·605
0·71	10·625	1·41	16·973	2·11	21·352	2·81	24·647
0·72	10·736	1·42	17·048	2·12	21·405	2·82	24·689
0·73	10·846	1·43	17·122	2·13	21·457	2·83	24·731
0·74	10·956	1·44	17·196	2·14	21·510	2·84	24·772
0·75	11·065	1·45	17·269	2·15	21·562	2·85	24·813
0·76	11·175	1·46	17·342	2·16	21·614	2·86	24·854
0·77	11·284	1·47	17·414	2·17	21·666	2·87	24·895
0·78	11·393	1·48	17·485	2·18	21·718	2·88	24·936
0·79	11·503	1·49	17·555	2·19	21·769	2·89	24·976
0·80	11·608	1·50	17·624	2·20	21·820	2·90	25·017
0·81	11·712	1·51	17·693	2·21	21·871	2·91	25·057
0·82	11·816	1·52	17·761	2·22	21·922	2·92	25·098
0·83	11·919	1·53	17·829	2·23	21·973	2·93	25·138
0·84	12·023	1·54	17·897	2·24	22·023	2·94	25·179
0·85	12·126	1·55	17·965	2·25	22·074	2·95	25·219
0·86	12·229	1·56	18·033	2·26	22·124	2·96	25·259
0·87	12·331	1·57	18·101	2·27	22·174	2·97	25·298
0·88	12·433	1·58	18·169	2·28	22·224	2·98	25·338
0·89	12·532	1·59	18·237	2·29	22·274	2·99	25·372
						3·00	25·416

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TABLE OF FUNCTION X.

$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X	$\frac{a}{b}$	Function X
1·00	1·653	5·60	3·308	10·20	3·906	26·0	4·831
1·10	1·738	5·70	3·326	10·30	3·916	26·5	4·851
1·20	1·817	5·80	3·344	10·40	3·926	27·0	4·870
1·30	1·891	5·90	3·361	10·50	3·936	27·5	4·889
1·40	1·960	6·00	3·378	10·60	3·946	28·0	4·908
1·50	2·027	6·10	3·395	10·70	3·956	28·5	4·927
1·60	2·090	6·20	3·412	10·80	3·966	29·0	4·946
1·70	2·148	6·30	3·428	10·90	3·975	29·5	4·964
1·80	2·202	6·40	3·444	11·00	3·984	30·0	4·982
1·90	2·250	6·50	3·460	11·10	3·993	30·5	4·999
2·00	2·296	6·60	3·475	11·20	4·002	31·0	5·016
2·10	2·340	6·70	3·490	11·30	4·011	31·5	5·033
2·20	2·383	6·80	3·505	11·40	4·019	32·0	5·050
2·30	2·425	6·90	3·519	11·50	4·027	32·5	5·066
2·40	2·466	7·00	3·533	11·60	4·035	33·0	5·082
2·50	2·514	7·10	3·547	11·70	4·043	33·5	5·098
2·60	2·551	7·20	3·561	11·80	4·051	34·0	5·114
2·70	2·586	7·30	3·574	11·90	4·059	34·5	5·129
2·80	2·620	7·40	3·587	12·00	4·067	35·0	5·114
2·90	2·652	7·50	3·600	12·5	4·107	35·5	5·159
3·00	2·683	7·60	3·613	13·0	4·145	36·0	5·173
3·10	2·715	7·70	3·626	13·5	4·183	36·5	5·187
3·20	2·747	7·80	3·639	14·0	4·220	37·0	5·201
3·30	2·779	7·90	3·651	14·5	4·256	37·5	5·215
3·40	2·810	8·00	3·662	15·0	4·290	38·0	5·228
3·50	2·841	8·10	3·674	15·5	4·323	38·5	5·241
3·60	2·871	8·20	3·686	16·0	4·355	39·0	5·253
3·70	2·899	8·30	3·698	16·5	4·386	39·5	5·265
3·80	2·925	8·40	3·710	17·0	4·416	40·0	5·277
3·90	2·950	8·50	3·722	17·5	4·445	41	5·300
4·00	2·974	8·60	3·733	18·0	4·474	42	5·323
4·10	2·998	8·70	3·744	18·5	4·501	43	5·346
4·20	3·022	8·80	3·755	19·0	4·527	44	5·368
4·30	3·045	8·90	3·766	19·5	4·552	45	5·390
4·40	3·067	9·00	3·777	20·0	4·576	46	5·411
4·50	3·089	9·10	3·788	20·5	4·599	47	5·432
4·60	3·111	9·20	3·799	21·0	4·622	48	5·452
4·70	3·132	9·30	3·810	21·5	4·644	49	5·472
4·80	3·153	9·40	3·821	22·0	4·666	50	5·492
4·90	3·173	9·50	3·832	22·5	4·688	51	5·512
5·00	3·193	9·60	3·843	23·0	4·709	52	5·531
5·10	3·213	9·70	3·853	23·5	4·730	53	5·550
5·20	3·233	9·80	3·864	24·0	4·751	54	5·569
5·30	3·252	9·90	3·875	24·5	4·771	55	5·587
5·40	3·271	10·00	3·886	25·0	4·791		
5·50	3·290	10·10	3·896	25·5	4·811		

where

L = inductance in cms.

K = capacity in micro-farads.

Example.—Take the case of the inductance worked out above, call this 2,902,000 cms. Let this be oscillating with a condenser having $K = 0{\cdot}001$ micro-farads.

$$\text{Then } \lambda = 59{\cdot}6\sqrt{2{\cdot}902 \times 10^6 \times 0{\cdot}001}$$

$$= 3211 \text{ metres wave-length.}$$

$$\text{and } f = \frac{5{\cdot}033 \times 10^6}{\sqrt{(2{\cdot}902 \times 10^6 \times 0{\cdot}001)}}$$

$$= 93{,}428 \text{ cycles per second.}$$

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TABLE OF CORRECTIONS FOR INSULATION.

NOTE.—For $\frac{d}{D}$ over 0·58 A is positive. For $\frac{d}{D}$ less than 0·57 A is negative.

$\frac{d}{D}$	A	$\frac{d}{D}$	A	$\frac{d}{D}$	A	$\frac{d}{D}$	A
1·00	+0·5568	1·75	0·2691	0·50	0·1363	0·25	0·8294
1·99	0·5470	1·74	0·2556	0·49	0·1558	0·24	0·8699
1·98	0·5370	1·73	0·2419	0·48	0 1758	0·23	0·9121
1·97	0·5268	1·72	0·2282	0·47	0·1966	0·22	0·9566
1·96	0·5163	1·71	0·2143	0·46	0·2183	0·21	1·0035
1·95	0·5055	1·70	0·2001	0·45	0·2406	0·20	1·0526
1·94	0·4947	1·69	0·1857	0·44	0·2632	0·19	1·1046
1·93	0·4839	1·68	0·1710	0·43	0·2864	0·18	1·1601
1·92	0·4731	1·67	0·1560	0·42	0·3102	0·17	1·2179
1·91	0·4623	1·66	0·1410	0·41	0·3347	0·16	1·2777
1·90	0·4515	0·65	0·1261	0·40	0·3594	0·15	1·3402
1·89	0·4404	0·64	0·1105	0·39	0·3846	0·14	1·4082
1·88	0·4292	0·63	0·0947	0·38	0·4106	0·13	1·4822
1·87	0·4178	0·62	0·0787	0·37	0·4374	0·12	1·5627
1·86	0·4063	0·61	0·0625	0·36	0·4647	0·11	1·6510
1·85	0·3945	0·60	+0·0460	0·35	0·4929	0·10	1·7451
1·84	0·3826	0·59	+0·0293	0·34	0·5219	0·09	1·8470
1·83	0·3706	0·58	+0·0123	0·33	0·5521	0·08	1·9642
1·82	0·3585	0·57	—0·0048	0·32	0·5831	0·07	2·0971
1·81	0·3463	0·56	—0·0226	0·31	0·6148	0·06	2·2550
1·80	0·3337	0·55	0·0410	0·30	0·6471	0·05	2·4389
1·79	0·3210	0·54	0·0597	0·29	0·6806	0·04	2·6952
1·78	0·3082	0·53	0·0787	0·28	0·7154	0·03	3·0250
1·77	0·2954	0·52	0·0980	0·27	0·7519	0·02	3·4620
1·76	0·2824	0·51	0·1173	0·26	0·7896	0·01	4·0483

TABLE OF CORRECTIONS FOR THE NUMBER OF TURNS.

NOTE.—All positive.

n	B	n	B	n	B	n	B
1	0·0000	31	0·3091	61	0·3219	91	0·3271
2	0·1137	32	0·3099	62	0·3222	92	0·3272
3	0·1663	33	0·3106	63	0·3224	93	0·3273
4	0·1973	34	0·3113	64	0·3227	94	0·3274
5	0·2180	35	0·3119	65	0·3229	95	0·3275
6	0·2329	36	0·3125	66	0·3231	96	0·3276
7	0·2443	37	0·3131	67	0·3233	97	0·3277
8	0·2532	38	0·3137	68	0·3235	98	0·3278
9	0·2604	39	0·3143	69	0·3237	99	0·3279
10	0·2664	40	0·3148	70	0·3239	100	0·3280
11	0·2710	41	0·3153	71	0·3241	105	0·3284
12	0·2753	42	0·3157	72	0·3243	110	0·3288
13	0·2791	43	0·3161	73	0·3245	115	0·3292
14	0·2826	44	0·3165	74	0·3247	120	0·3295
15	0·2857	45	0·3169	75	0·3249	130	0·3301
16	0·2885	46	0·3173	76	0·3251	140	0·3307
17	0·2910	47	0·3177	77	0·3252	150	0·3311
18	0·2933	48	0·3180	78	0·3253	160	0·3315
19	0·2955	49	0·3183	79	0·3255	170	0·3319
20	0·2974	50	0·3186	80	0·3257	180	0·3323
21	0·2990	51	0·3189	81	0·3259	190	0·3326
22	0·3005	52	0·3192	82	0·3261	200	0·3328
23	0·3020	53	0·3195	83	0·3263	250	0·3336
24	0·3031	54	0·3198	84	0·3264	300	0·3343
25	0·3042	55	0·3201	85	0·3265	400	0·3351
26	0·3053	56	0·3204	86	0·3266	500	0·3356
27	0·3062	57	0·3207	87	0·3267	600	0·3359
28	0·3070	58	0·3210	88	0·3268	700	0·3361
29	0·3077	59	0·3213	89	0·3269	800	0·3363
30	0·3083	60	0·3216	90	0·3270	900	0·3364
						1000	0·3365

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Pioneer Lady Operators at Towyn Wireless Station

WITH its land operating staff cut down to a minimum, and an ever-increasing volume of traffic to handle, the Marconi Wireless Telegraph Co., Ltd., has for some time had under careful consideration the question of employing lady operators at some of its high-power land stations. A school for training them was therefore opened at special premises in February and closed on September 30th, 1916. Mr. C. W. Pain, late of the Clifden station, acted as instructor at the school, the curriculum of which included slip reading, punching, record reading, sending on long land lines, and the general duties appertaining to a commercial wireless station. All the ladies were obliged to undertake to perform night duty as well as day duty. As the experiment stands up to the present, the Wireless Company has been provided with a number of experienced lady telegraphists, specially trained in wireless work who—their course of instruction completed—have been appointed to certain duties at the important station at Towyn, in North Wales. These ladies have been carrying on their new work for some weeks now, and as time goes on they will in due course be given opportunities for working wireless instruments.

We reproduce below a photograph of these pioneers, only one of whom (Miss Bruton) has at the time of writing fallen out. The names of the ladies run as follows : Top row—Misses W. F. Bruton, A. V. Edgar, D. M. Jarred and F. M. Rogers. Bottom row—Misses E. A. Pugh, M. Beresford, R. Perry, G. A. March, and M. Murphy.

A GROUP OF PIONEERS:—LADY OPERATORS AT THE TOWYN WIRELESS STATION.

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Digest of Wireless Literature

The Distribution of Standard Time in the United States.

Interesting particulars regarding the distribution of time in the United States were recently published in our contemporary the *Telegraph and Telephone Age.*

Time is obtained accurately by the astronomers at the United States Naval Observatory at Washington, D.C., observing the transit of certain stars every clear night, which are due to cross the meridian at a known time. The exact instant of their transit is recorded electrically by means of a chronograph, which also records the seconds from a sidereal clock. The difference between the time the stars cross and the time of the sidereal clock, as recorded on the chronograph, shows the error of the clock.

Time is transmitted daily from Washington to the Panama Canal for the purpose of correcting ships' chronometers. Correct time is highly important for a vessel, because in making observations of heavenly bodies a variation of one second means an error of about one-fourth of a nautical mile in location. The time signal is sent by wire from Washington to Key West, whence a relay transmits it by wireless. The Darien wireless station in the Canal Zone in turn transmits the signal by ordinary telegraph to the port captains' offices.

The signal is sent from Key West in a series of dots. Five minutes before noon the wireless begins counting off the seconds by dots. After the twenty-eighth second there is a pause, the 29th dot being omitted; similarly there is a pause from the 54th to the 60th second. The count is resumed exactly on the minute. This procedure is kept up until 10 seconds before 12 o'clock, when there is a pause followed by a long dash at exactly 12 o'clock. The aerial transmission is recorded at Darien by a current too slight to permit ordinary relaying. Consequently an operator with a wireless receiver at his ears sends dots through an ordinary telegraph wire to the port captains. With practice he can strike the dots on his sending key in almost perfect synchronism with the dots received. The principal difficulty is in sending the final dash after a wait of 10 seconds. Here the tests show that the lag is between two-tenths and three-tenths of a second. By making allowance for this lag the chronometers in the Canal Zone can be adjusted to within about one-tenth of a second of the correct time. Arrangements are being made to instal a clock at Darien which will transmit the time exactly as received from Key West.

* * * * * *

Military Wireless on the Mexican Railways.

When the United States troops went into Mexico, says the *Popular Science Monthly,* they were forced to meet a number of unusual conditions. In Vera Cruz, for example, they found new and difficult situations, and their ingenuity in overcoming some of these handicaps is interesting.

A train was run twice daily under a flag of truce from Vera Cruz to the Interior. This was always accompanied by a small guard. Inasmuch as a treacherous attack upon the cars was likely to occur at any time, it was considered desirable to keep in communication with the trains. Since this could not be accomplished in any other

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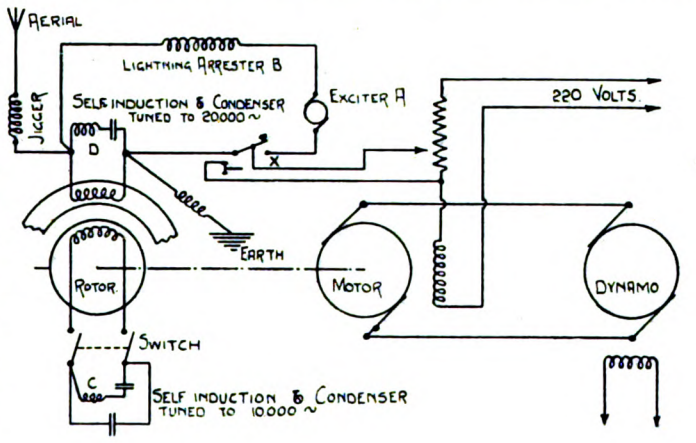
way than by wireless, a complete installation was made in one of the passenger coaches. An upright was erected at each end of the car, and the aerial wires were strung between cross-arms mounted upon these. The instruments themselves were placed upon the cushioned seats within the car, thus avoiding difficulty from vibration. The ground connection was made through the trucks of the car, and the power for the transmitter was supplied by a small hand-power generator. A fixed wireless station was also installed at headquarters in Vera Cruz, and messages were exchanged between this plant and that on the train, even when the latter was in motion.

* * * * * *

THE GOLDSCHMIDT HIGH-FREQUENCY ALTERNATOR.

In an article published in the *Annales des Postes, Télégraphes et Téléphones*, entitled "Radiotelegraphy over Great Distances," Mr. W. Duddell, the well-known wireless investigator, deals with the various methods employed at high-power wireless stations. Speaking of the Goldschmidt high-frequency alternator, he says that if we take a three-phase machine excited by continuous current, this machine giving a current of frequency N, then the current produced in the rotor of a second machine similar to the first will produce a current of frequency 2N. One is able to add a third machine, in which there will be a current of 3N.

Goldschmidt's idea was to combine these machines in one, and put the different portions in resonance for each of the apparatus dealt with. To obtain the same result one may use a single-phase alternator. The stator is energised by continuous current, and it produces in the other a current of frequency N, which is led into a circuit comprised in the rotor tuned to this frequency. The field produced reacting on the stator gives a current of frequency 2N. This current reacts on the rotor and gives a current of frequency 3N, which reacts again on the rotor and gives another current of frequency 4N; this serves to excite the antenna.



Small machines of this type have given good results. As an experiment, says Mr. Duddell, an alternator of 150 kw. has been built, but it is still on trial.

Our illustration will make Mr. Duddell's explanation clear.

* * * * * *

THE ALKALINE STORAGE BATTERY.

The effect of variations of temperature upon the performance of the Edison nickel-iron storage battery is the subject of a paper presented recently at the New York meeting of the American Electro-chemical Society by L. C. Turnock, of the

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Department of Chemical Engineering of the Carnegie Institute of Technology in Pittsburgh. The *Electric World*, in a summary of the paper, says that the author's rather extensive tests were made with an auxiliary test electrode consisting of a portion of one of the nickel hydrate tubes which compose the positive plates of the battery. In order to complete a cycle of charge and discharge within a convenient length of time a current rate of 15 amp. was employed; this is about twice that recommended as a "normal" rate, but the author thinks that the results obtained therewith under variable temperature conditions should be entirely comparable to those obtained at a lower rate.

Two cells were tested. Tests were carried out at temperatures varying between 20 and 90 degrees C. (68 and 194 degrees Fahr.), and the results are given in the original paper in a series of tables and diagrams. The chief results are summed up as follows:—

The available current efficiency of the battery at charge and discharge rates twice the value of the recommended "normal" rates increases up to 50 degrees C. (122 degrees Fahr.), after which it begins to fall off rapidly with further increase in temperature.

The current efficiency on discharge is higher than on charge, as evidenced by practically no gas evolution during discharge even at rates higher than "normal."

A more effective input into the battery is possible by keeping the temperature below 50 degrees C. (122 degrees Fahr.). The best electrical efficiency is obtained by charging at a low temperature and discharging at a higher temperature.

The operation of the battery at temperature above 50 degrees C. (122 degrees Fahr.) is detrimental to the life of the battery. The capacity of the positive or nickel hydrate electrode may be restored by an overcharge at a low temperature. The capacity of the iron or negative electrode will continue to be lost with operation at high temperatures, and the lost capacity cannot be restored with overcharging.

The presence of hydrogen peroxide in the electrolyte during the various states of charge of the battery may account for the low capacities experienced with the battery allowed to operate at high temperatures. On charge it functions as a reducing agent towards the positive electrode, and has the effect of an oxidising agent towards the negative electrode.

Another view explaining the low capacity of the positive and negative electrodes, and which the evidence so far obtained seems to support the more strongly, is as follows:—

On charge the nickel peroxide (NiO_2) and nickelic oxide (Ni_2O_3) form a solid solution, in which the concentration of NiO_2 in the equilibrium phase decreases with increase in temperature.

The highly active metallic iron of the charged negative plates is soluble in the electrolyte, and the rate of solution increases with increase in temperature. Solution of the iron in the electrolyte results in a permanent loss of capacity.

It is dangerous to allow the battery to become overheated and stand even on open circuit in a place that is not sufficiently ventilated, artificially or otherwise. Evolution of hydrogen and oxygen, in the proper proportion to form in themselves a highly explosive mixture, is evident at 50 degrees C. (122 degrees Fahr.), and the rate increases rapidly with increase of temperature.

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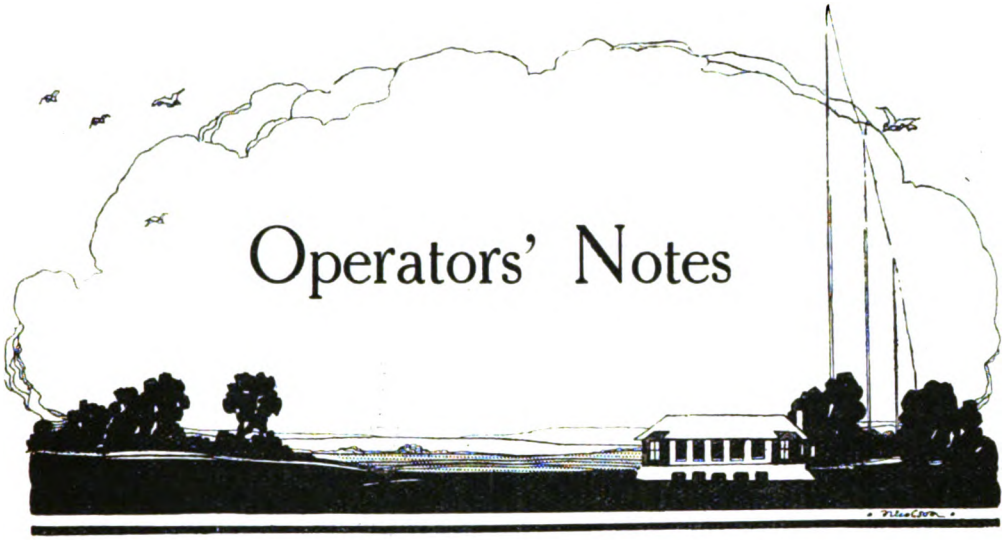

Operators' Notes

Faults on 1½ kilowatt set

(*Continued from page* 605.)

By W. D. LACEY

Three-Hundred-Metre Wave.—To connect for 300-metre wave, put transformer secondaries in series, main condenser in series, adjust amount of aerial-tuning inductance in accordance with engineer's diagram, and connect the short-wave condenser between the Bradfield insulator and the top-plate of a separate earth arrester gap. Lengthen the spark gap to 7 or 8 mm.

Emergency Set.—The procedure for getting a spark on the 10-in. induction coil is as follows:

First, try to get a voltmeter reading on marine switchboard. If the voltmeter gives a reading of slightly over two volts per accumulator connected, it proves the cells to be correctly joined and that current is being delivered to the switchboard. If no voltmeter reading is obtained, look to the fuse at bottom of switchboard, examine the accumulator connections and see that each cell is properly connected in series. Also note that the leads from the two bottom right-hand terminals of marine board are connected to the ends of the battery. A voltmeter reading should then be obtained. Next see the leads from the two bottom left-hand terminals of the marine board are connected to the back pair of terminals on the coil.

These coil terminals are marked *D*.

The manipulating key connects to two terminals on coil, marked *A*, immediately behind the commutator. The base condenser is connected by joining two pairs of terminals (marked *B* and *C*) with short copper rods.

These condenser terminals lie between the hammer break and the manipulating-key terminals.

The two ends of the primary winding are brought through the ebonite caps at either end of the coil and connect to two terminals, one on each support of the coil.

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When all these connections have been attended to (which should occupy only a few minutes), adjust the hammer break until it has a break of about $\frac{5}{32}$ or $\frac{1}{8}$ in. Note the connections between the secondary terminals and discharge rods are joined. Take care the key contacts are not screwed together.

All should now be ready to produce a spark.

First put the single-pole switch (on marine board) over to the left position (cells), put down commutator (on coil) and side lever of key. Upon working the key a spark should take place between the discharge rods.

Plain Aerial.—To work plain aerial, connect one discharge rod direct to the aerial and the other discharge rod to earth. A good plain aerial spark is very white, clear of furryness and gives a sharp crackling noise.

Tuned Emergency.—The plain aerial spark has several disadvantages, not the least of which is its effect upon the aerial insulators and platinum contacts. Therefore, it is desirable to provide means whereby the emergency gear can be coupled to the main transmitting apparatus. This is accomplished by disconnecting the transformer secondaries from the choke coils, and joining a wire from each discharge rod of coil to each choke coil. The spark length in the closed oscillatory circuit should be reduced to about 2 mm. as there is not the same amount of energy available for charging the condenser.

Extra Condenser.—For working the coil from the ship's mains (usually 60 or 100 volts) it is necessary to increase the size of the base condenser in order to minimise sparking at the hammer break. This is done by using an additional condenser of large value. It is connected to two terminals affixed to the interrupter and back-contact pillar.

Extra Charging Panel.—It is unlikely any faults will be placed on this piece of apparatus, but the student will do well to memorise the connections as given in the various diagrams.

The Receiver.—To correct faults on the receiving set is probably the easiest of the whole set.

The following procedure should be adopted.

First, connect leads from the top and bottom plates of the earth arrester gap to the "aerial" and "earth" terminals of the multiple tuner.

Connect the "detector" terminals of tuner to the *A* and *E* terminals of the magnetic detector. Join the *T* terminals of the detector to the telephone condenser and connect telephones. The buzzer should be adjusted for working, and the *A* and *E* terminals connected to the aerial and earth terminals of the multiple tuner. The reason for connecting the buzzer in this manner is that it gives indications of fault on tuner, which will be dealt with later.

Magnetic Detector.—Place the magnets in position (like poles together), wind the detector, and note if band rotates. Should the band remain stationary, see if the starting lever is in the "stop" position, or if there is too much tension on the band. If the band is too tight, slacken the adjusting screw until the band moves.

Now listen in 'phones and press buzzer key; if all is in order signals should be obtained. If the buzzer "clicks" it denotes a short circuit across tuner. It may be a short on the earth arrester gap, the micrometer gap screwed down, or the aerial tuning condenser at "short."

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After examining all these points and still no signals are heard, run over all connections once more, making sure each makes good contact with its terminal. Test primary and secondary of detector for continuity with cell and galvanometer. Test telephone receivers by placing the tags across a cell or buzzer.

Note that all switches of the multiple tuner are in the correct positions; the change-over switch should be in the "stand-by" position, the aerial tuning inductance should be at zero or a very small value, the tuning switch should be on the first position, and the intensifier handle at 90°. The aerial tuning condenser should be at a midway value.

In sets where the telephone short circuit device is connected on the manipulating key, take careful note that the key is not depressing the springs and thereby shorting the 'phones.

With all the foregoing points attended to the set will be in good working order.

The student need not expect to find all the faults mentioned in these articles, but may expect to find any of them, and a perusal of the foregoing methods of fault-finding will give him an idea of the correct procedure.

Administrative Notes

AZORES

THE Portuguese Administration advises that service through the coast station at Flores, the interruption to which has been previously advised, has again been renewed.

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FRANCE

Under date September 23rd, 1916, the French Administration advises that the coast stations Saintes Maries-de-la-Mer (France), Fort-de-l'Eau (Algeria) and Cap Bon (Tunis) are closed to public correspondence except for radiotelegrams exchanged between the master of a ship and the shipowners or charterers.

* * * * * *

GOLD COAST

We are advised that radiotelegrams originating in or destined to countries other than the Gold Coast and transmitted through the Accra coast station are subject to a land telegraph charge of 2d. per word, in addition to the usual radiotelegraph and cable charges.

The land telegraph charge is for the service between the Accra coast station and the connecting cable office at Accra.

Example.—The total tax on a radiotelegram destined to London and transmitted from a ship to the Accra coast station would be assessed :—

Ship station tax : Radiotelegraph Service.
Coast station tax : Radiotelegraph Service.
Land telegraph tax : Accra coast station to Accra cable office.
Cable tax : Accra to London.

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PERU

The Peruvian Administration advises us that it has modified the call signals assigned for the radiotelegraphic service to Peruvian coast stations, naval stations, and ships of the National Mercantile Marine.

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The new call signals have been assigned as follows, and will be brought into use immediately :—

COAST STATIONS.	*Call Signals.*
Callao	OAA
Chala	OAC
Ilo	OAL
Iquitos	OAY
Masisea	OAM
Orellana	OAO
Pisco	OAP
Putumayo	OAU
Puerto Bermudez	OAE
Requena	OAQ
San Cristóbal	OAZ

NAVAL STATIONS.	
Almirante Grau (Warship)	OBG
Chalaco (Transport)	OBC
Constitución (Transport)	OBO
Coronel Bolognesi (Warship)	OBB
Explosive Deposit	OBD
Ferré (Submarine)	OBF
General Staff of the Navy	OBM
Iquitos (Transport)	OBY
Lima (Warship)	OBL
Palacios (Submarine)	OBP
Submarine Station	OBS
Teniente Rodríguez (Warship)	OBR

NATIONAL MERCANTILE MARINE.	
Huallaga	OCH
Mantaro	OCM
Pachitea	OCP
Ucayali	OCU
Urubamba	OCR

UNITED STATES

OFFICIAL notification has been received of a change in the names of two important American coast stations.

" Arlington Radio " and " Mare Island " stations are now known as "Washington NAA " and " San Francisco NPH " respectively, the call signals having been added to distinguish them from other stations of the same names.

No alteration is made in regard to the transmission of time signals, weather reports, navigation warnings, and other services performed by these stations.

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"A Text-Book of Practical Physics"*

By H. S. ALLEN, M.A., D.Sc., and H. MOORE, A.R.C.S., B.Sc., Lecturers in Physics at King's College, London. Reviewed by Professor G. W. O. HOWE, D.Sc., M.I.E.E.

ALTHOUGH intended primarily as a book of instruction for the course in Practical Physics at King's College, the volume under review will undoubtedly prove of great service to all teachers of the subject. It covers a wide range, starting with simple elementary experiments and including the greater part of the practical physics required for a pass degree in science at most universities. The fact that engineering students in the University of London are required to take a practical course in applied mathematics, explains the presence of a larger number of experiments in practical mechanics than is usual in a text-book of practical physics.

Most of the experiments described are such as can be carried out with simple apparatus. The authors very properly deprecate the use of elaborate semi-automatic apparatus in a laboratory intended for teaching students the fundamental principles of physics. Stress is laid throughout on the degree of accuracy obtainable with the apparatus employed. The course mapped out and the methods employed are certainly calculated to develop the capability of carrying out original investigation and research.

The book is divided into six parts, dealing respectively with properties of matter, sound, light, heat, magnetism and electricity. The first part is sub-divided into eleven chapters, the first of which is introductory and describes the methods preferably employed in recording, working out, and finally writing up the results of an experiment, the accuracy of observations, null versus deflection methods, the use of graphs, etc. All teachers of applied science know the weakness of students for working out results to four or five decimal places when some of the observations have a probable error of 1 per cent. The authors caution students against such misplaced zeal. Attention is rightly directed to the necessity of mastering the theoretical principles involved, and of thoroughly understanding the purpose of the experiment, also of studying carefully the apparatus employed and the details of setting it up and adjusting it.

Chapter II. deals with fundamental measurements—i.e., of mass, length and time. Chapter III. with areas, including the theory and use of the planimeter, and with radii of curvature of lenses, etc. Chapter IV. embraces the various methods of determining the specific gravity of solids and liquids. Chapter V. deals with forces in equilibrium, levers, centre of gravity, inclined plane, etc. Chapter VI. with the efficiency of simple machines, and Chapter VII. with elasticity and Young's modulus. Chapters VIII. and IX. are devoted to dynamics, including the oscillation of pendulums, magnets, etc. Chapter X. to the barometer and Boyle's law, and Chapter XI. to surface tension and capillary phenomena.

The section on Sound consists of three chapters and covers the usual

* "A Text-Book of Practical Physics." By H. S. Allen, M.A., D.Sc., and H. Moore, A.R.C.S., B.Sc. London, 1910. Macmillan & Co., Ltd. 8s. 6d. net.

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experiments on resonance tubes, determination of pitch by a siren, by Kundt's tube, vibration of stretched strings, etc.

Part III., Light, contains eight chapters, of which the first deals with simple reflection and refraction, the second, third and fourth with mirrors and lenses, the fifth with the optical bench, the sixth with microscopes and telescopes, the seventh with the spectroscope, and the eighth and last with photometry.

The section on Heat contains seven chapters, dealing respectively with thermometry, coefficients of expansion, calorimetry, cooling, thermal conductivity, the mechanical equivalent of heat, and hygrometry.

Part V. deals with Magnetism, and is subdivided into five chapters. Chapter I. contains simple experiments with magnetic needles, such as mapping out magnetic fields; Chapter II. is on magnetometry, and Chapter III. on the oscillation of a magnet in a magnetic field. In Chapter IV. simple methods are described of determining the various elements of the magnetic field of the earth.

Last, but certainly not least to the readers of this journal, are the chapters devoted to Electricity. In accordance with classical precedent, the first chapter deals with electrostatic experiments, which have become of increasing importance with the growth of wireless and other branches of high-frequency work. Chapter II. deals with the mapping out of the magnetic field due to conductors and coils carrying current. In Chapter III. are described methods of calibrating galvanometers and ammeters. Chapter IV. deals with potential difference, electromotive force, and the potentiometer, Chapter V. with the measurement of resistance, Chapter VI. with voltameters, and Chapter VII. with the heating effect of the current. Chapter VIII. is more ambitious and deals with induced currents, induction coils, transformers, dynamos, and motors. Three methods of comparing the capacities of condensers are given in Chapter IX. The concluding chapter consists of a number of notes on various pieces of electrical apparatus—e.g., keys, switches, galvanometers, rheostats, etc.

At the end of every section is given a very useful list of additional exercises. A number of tables of useful physical constants is given in an appendix, which also includes a table of logarithms.

The general get-up of the book is good, important points are brought out by being printed in heavier type, and the book is well illustrated with practical diagrams. It is a book which can be unreservedly recommended to all students of physics.

Searchlights

THERE must be few readers to whom the beams of the searchlights are not a familiar sight, and considerable interest has been aroused, since the perfection of England's anti-aircraft defences, on the wonderful instruments which pierce the sky and ferret out the aircraft of the enemy. We have recently received from Messrs. Crompton & Co., Limited, of Chelmsford, the well-known searchlight specialists, an illustrated list of searchlights of all types ranging in size from 12 inches to 84 inches in diameter, and fitted with every device to facilitate their operation. Messrs. Crompton have developed their present searchlights as a result of many years' experience, and will be pleased to forward to all interested full information as regards price, weights, measurements, etc.

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Wireless Telegraphy In the War

RUDYARD KIPLING ON DESTROYERS' WIRELESS.

In his recent delightful articles on " Our Destroyers in the Battle of Jutland," the most distinguished of British journalists puts forward a possible solution of the way in which the Germans may have acquired the belief that they sank certain British vessels. This explanation is that, owing to the difficulty of distinguishing friends from foes, an enemy vessel may have " finished off " one of their own vessels and wirelessed the information to headquarters, utterly oblivious of the fact that the victim was not British at all. If this very plausible theory be correct, we have in the German version of Jutland yet farther examples of the way in which our enemies select from their " Wireless Reports " only such items as happen to suit the purpose of the moment.

In the same series, Mr. Rudyard Kipling draws a very vivid sketch of the dangers that may be involved if " Jos jambs wireless orders at the last moment." It is quite " on the cards " that more than one actual happening may be adumbrated in the picture drawn as a "draft on fancy " by the famous Anglo-Indian writer. What the verbal sketch limned by his imaginative pen amounts to, is this: British destroyers are out on a cruise, and have been " wirelessed " that a certain class of warships is being kept out of the business in hand. Therefore, if they see any vessels bearing the distinctive appearance of this class, they can assume that they are Germans masquerading as British, and " strafe " them accordingly. A later wireless message correcting the stay-at-home order for this type of British vessel fails to reach them. When the destroyers sight such vessels what are they to do ? Kipling answers the enquiry in his own characteristic style.

At another point in this same thrilling set of articles, the creator of *Soldiers Three* dwells upon the powers of British Naval improvisation. He is describing the terrible scenes on board a badly battered British ship, when the First Lieutenant " took charge of affairs whilst his Commander was being extricated from the bridge " wreckage." The imagination of Wireless men will be able to riot over the possibilities suggested by the description of how this lieutenant " in his leisure, improvised " means of signalling " ; for we read a little further on that " the searchlight and "wireless were tangled together and the electricity leaked into everything." Yet

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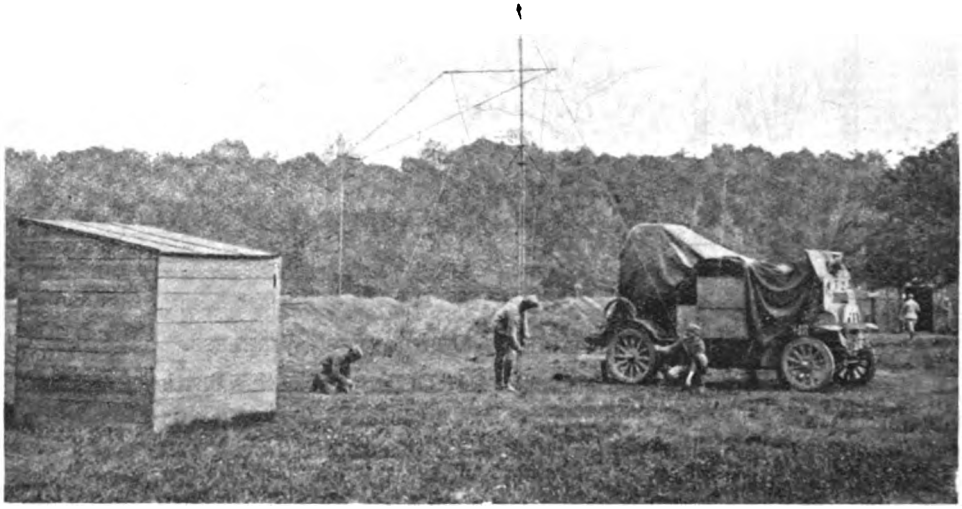

[Newspaper Illustrations.

FIELD WIRELESS ON THE WESTERN FRONT.

in the midst of this "leakage" the lieutenant was at work bringing order out of chaos, and the surgeon—a probationer—performed an amputation single-handed.

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TEUTONIC "PROSTITUTION OF SCIENCE."

Nothing is more striking, when we come to review the "manners and customs" of our enemies than what we may call "their prostitution of science." They have systematically employed poison gas in various hideous forms, despite a formal peace-time agreement amongst civilised nations that such means should not be employed in warfare. They have introduced chemical poisons into drinking wells and rendered them death-traps for men and beasts. Discoveries recently made at the German Embassy in Bucharest show that the German Diplomats had there amassed a large store of the serum of anthrax, with a view of introducing that virulent disease into Roumania by inoculation, as soon as she should have declared herself on the side of the Allies, and we understand that a German plot was recently discovered for similarly infecting animals destined for Canada and turning them loose in the Dominion. We all of us remember how, a short while ago, when the Roumanian bulletins contained a reference to poisoned sweets thrown down from German aircraft, the Enemy Press "explained," and the Enemy Wireless circulated the "explanation" that the sweets referred to did not contain poisons, but explosives! All these things are the result not of hasty resolve, but of careful preparation spread over a large number of years, during which German hypocrisy was busily engaged in framing International Rules against such proceedings and inducing other nations to subscribe to them. The dates upon the poison apparatus captured by the British speak for themselves.

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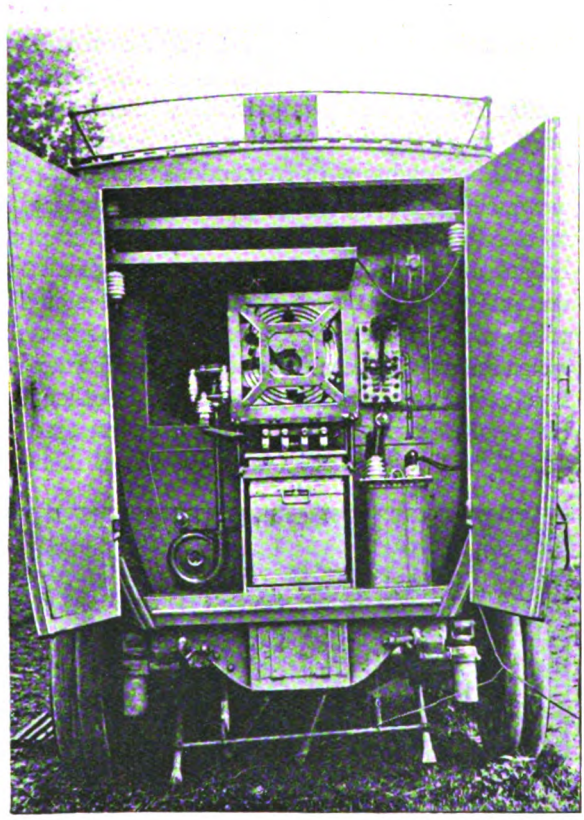
Perhaps of all modern applied sciences the most completely exploited for their evil purpose has been, and is, wireless telegraphy. This invention conferred upon their Zeppelins powers which otherwise could never have been theirs. Not content, however, with employing those really wonderful examples of ingenuity in their legitimate function as air-scouts, they despatched them upon raids which even their would-be-apologists can scarcely differentiate from murder-tours. The German Government induced the representatives of other Powers to agree in the universal interest to the limitation of the power of steamship installations. Their State-controlled and State-subsidised shipping lines straightway utilised these restrictions for putting their own vessels in a state of wireless superiority. There can be little doubt that this practice was responsible for enabling the *Greif* to blanket the wireless of the *Alcantara*, so long as the installation on the German ship was capable of working. Everywhere Germany has endeavoured to utilise the immunity from attack secured them by the benefit of neutrality to violate every wireless regulation of their hosts. Over and over again Swedish, Dutch, American, and other authorities have had to discover and suppress fresh attempts in this direction. No respect either Divine or human appears to restrain them.



[N. Wayland Illustrations.

A FRENCH PORTABLE EQUIPMENT ON THE WESTERN FRONT.

Over-reaching Themselves.

The fact that wireless alone enables the Central Powers to keep in direct touch with the world outside their own territory and that of their immediate neighbours, necessarily forces them to utilise radio-telegraphy for their propaganda work. No one can find any fault with them for that. But they have so prostituted the opportunity given them by this most modern of sciences, that the British Censors are enabled to pass a considerable proportion of their accounts for publication in our own newspapers, secure in the knowledge that their misrepresentations are so patently

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ridiculous as to defeat the object of their originators. An interesting analysis of the German wireless *communiqués* was recently issued. The analyst therein exposed our enemy's attempt to dwarf the real successes of the French and British by the invention of a whole series of imaginary battles which never had any existence except in the wireless waves radiated into the ether from German stations. From day to day, throughout the end of October and the beginning of November, these fictional wireless battles " continued," or " went on with great severity," or " are " still maintained with undiminished acerbity." The actual battle-line scarcely exceeded three miles. But this " war zone " was totally inadequate for the German " Wireless Liars," and their radio service accordingly inundated the whole front with (imaginary) French and British blood. According to these fabulists " our brave " infantry, excellently supported by the artillery and airmen " were kept continually busy " repulsing," " smothering," " beating off," or " breaking down " the reckless British onslaughts with tremendous slaughter. Having created these vast conflicts in which they assigned themselves the victory, it became comparatively a simple matter to slip in such little affairs as the recapture of the Verdun positions by the French, or the taking of the Stuff and Regina trenches by the British. We might go on multiplying instances indefinitely ; but enough has been said amply to support the point, which we have endeavoured to bring home before our readers, of the extent to which science has been debased by its utilisation in the present war by our enemies. Is it a matter of wonder that—only the other day—an independent member of the House of Commons, when asking about an aged German scientist, unnaturalised, yet alleged to be still doing work for the British Government, protested in advance

[Newspaper Illustrations.

A POILU WORKING WIRELESS IN A DUG-OUT.

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against the favourite official justification of "an aged and innocent Professor"? Science to Germany means but fresh methods of destruction, and German scientists are so corrupted through and through by this spirit, that we should hesitate to believe any one of them to be "simple" or "immersed solely in technical pursuits."

* * * * * *

German Vapourings and British Reticence.

The voyaging of the *U*53 to and from the United States does not demonstrate any new facts; British submarines have performed cruising exploits of a more remarkable nature, and we recently saw a photograph taken on board a British submarine in mid-ocean, whilst she was in the course of performing a 5,000 mile voyage. What it *does* do, is to furnish a fresh indication of the complete nature of Germany's subjugation at sea, and a fair illustration of the German's estimate of President Wilson's notes. Our foe is fully as well aware as ourselves of the drawbacks of under-water craft as substitutes for surface vessels; and would never so employ them if they could help themselves.

[*Underwood & Underwood*

ON A BRITISH SUBMARINE IN MID-OCEAN

We notice that press accounts of the wireless on these up-to-date submarine cruisers is described as being of a specially powerful nature. We have seen no direct evidence that this is so, for the fact that *U*53 wirelessed messages in code to Count Bernstorff as soon as she neared American neutrality waters is not in itself inconsistent with her being fitted with the ordinary submarine wireless apparatus. Such installations are capable of transmitting over a radius of sixty miles. Assuming, however, that the printed reports are accurate in this respect, it would tend to show the way in which Germany, unable to employ submarines in their proper rôle as subordinate units acting in conjunction with surface vessels, is obliged to introduce modifications into the construction of the former, in order to give them a fair chance of playing a part for which they are radically unsuited. It is significant of the supreme importance of wireless at sea that the wireless warnings issued in all directions as soon as the shipping people on the other side realised what was going on, resulted in the preservation of many possible victims. No more eloquent justification of the recent Government action with regard to the compulsory wireless could possibly have been afforded. The only wonder is that any compulsion should have been necessary.

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War Notes

Outrages against Hospitality.

We refer on another page to the violation of neutral hospitality by German illicit wireless. There have been many cases in point all through the war, but the instance of the North German Lloyd Steamer *Willehad* possesses some characteristics of its own. It would appear that, although the vessel was brought to New London (Conn.) from Boston on August 25th, and her Wireless Apparatus sealed by the American authorities, the resourceful Teuton was able to organise an ingenious device for getting round the American Regulations. A floating barrier and a gate 30 feet high were erected, ostensibly for screening from observation any German submarines which might arrive. Under the cover of this structure, wires were stretched between the piling under the pier and that to which the *Willehad* was made fast in such a way as to create a Wireless Aerial. Such installations as these, which owe their immunity from destruction to location under a neutral flag, cannot be otherwise characterised than as outrages against hospitality.

* * * * * *

Some Chicago "Mustard."

Our readers will be amused by the following pungent American suggestion that President Hughes may utilise Wireless and "damn the expense!" We cull the passage from the *Chicago Tribune*, part of whose sarcastic editorial runs as follows :—

"We said *tweet* to Germany over our 'strict accountability' about "the *Lusitania* and *Sussex;* we *chirp* to Great Britain about 'mail "'interference.'

"Tweet and chirp to Germany and Great Britain. Why? Because we have "nothing but a tweet and chirp in our organisation. We must tolerate things "because we are not strong enough to remedy them. We have the price of ink and "cable-tolls. We can use the Wireless if necessary. Ding the expense of trans-"mitting what we think of Powers which do us injury!

"But as for making it inconvenient for Powers to do us injury—China and the "United States are companions in unhappiness."

* * * * * *

Wireless Spoils of War.

Amongst the list of miscellaneous material captured by the French from the Germans in their recent successes on the Verdun front, the official bulletin includes two Wireless Telegraphy posts, besides a number of heavy guns, 51 trench mortars, 144 machine guns, and a large quantity of rifles, grenades, shells and *matériel*. Such losses of the enemy are becoming of increased importance, in view of his difficulty in making up deficiencies. We have already had occasion to comment upon the lack of Wireless equipment referred to in Von Arnim's report.

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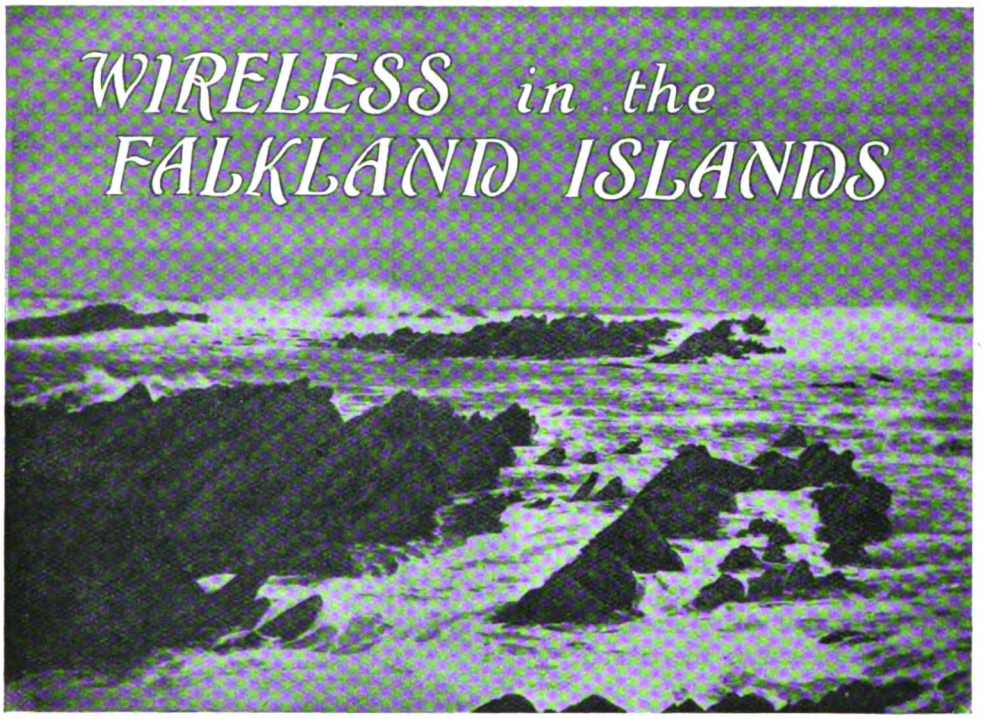
WIRELESS in the FALKLAND ISLANDS



By W. D. LACEY

It may be of some interest to readers to learn a little of the manner of life led by the operators on far distant radio stations, both before and since the war.

Before the war the writer, with one assistant, was appointed to the station at Port Stanley, in the Falkland Islands, and proceeded thence in August, 1912. After a pleasant voyage lasting a month, the ship arrived late at night off the East Island, and the only sign of life to be observed was the flashing of the lighthouse on Cape Pembroke. All that could be seen of the island were the black forbidding outlines of the hills behind the harbour. Not wishing to form a prejudiced opinion of the position before making a closer acquaintance with the place, I thought the best thing to do would be to retire until daylight. Upon waking the following morning we found the vessel had entered the harbour, where one small and one smaller tug were making the seven miles of harbour appear to be hustling "some." About three miles east from the township (I mustn't call it a village), the masts of the wireless station could be clearly discerned together with what appeared to be two stone buildings.

It looked rather a pretty station from a distance, but appearances are often deceptive, as after acquaintance proved. At breakfast, before going ashore, we were approached by a Customs officer, who inquired after us by name, with a request not to go ashore until His Excellency sent off the Government pinnace for our conveyance, whereat visions of an elegant and smartly manned launch flashed across one's mind.

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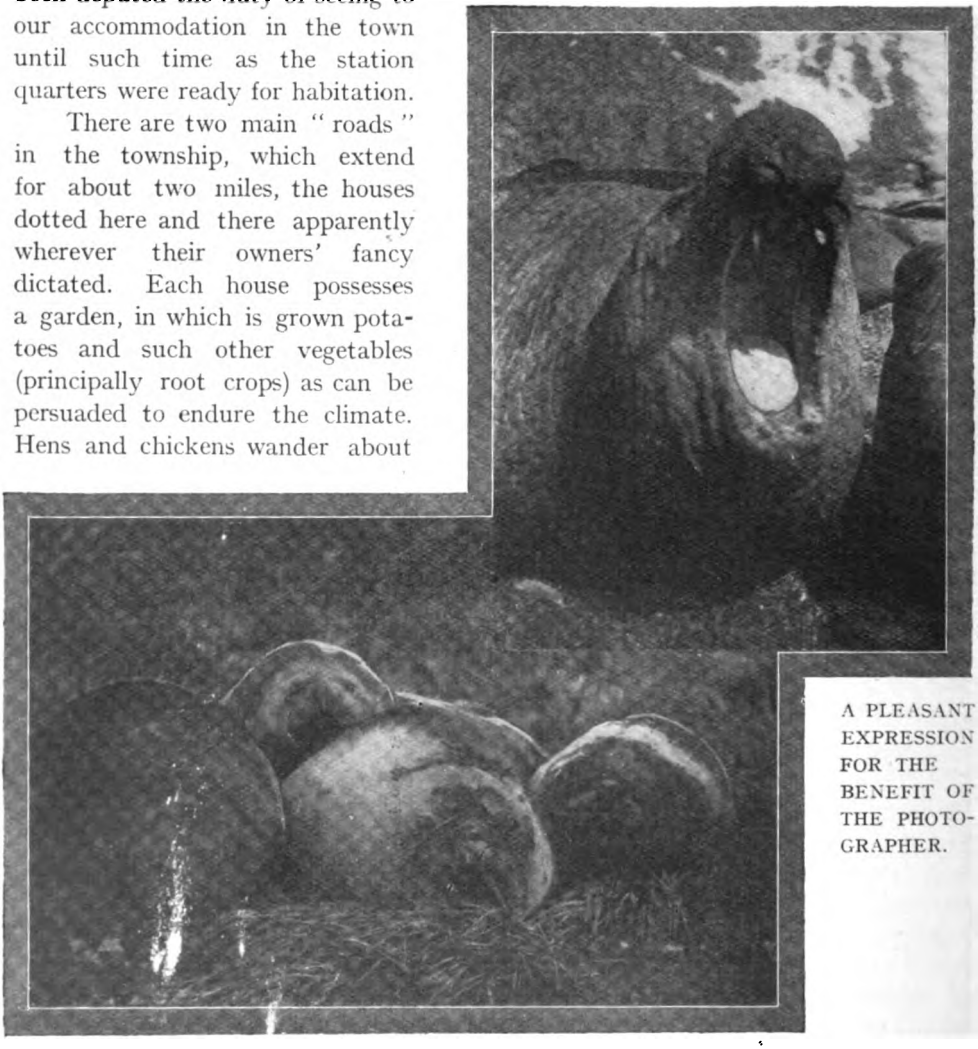
The disillusionment came when someone pointed out a black-painted launch approaching at about five knots, and said : " That is the Governor's launch." After circling the ship to find the gangway, the aforementioned launch " tied up " alongside and was seen to be manned by a longshoreman and a labourer, whilst the engineer's head protruded through a manhole, surveying things in general with the aid of a pipe.

Eventually arrived ashore, we were there met by the Chief Constable, who had been deputed the duty of seeing to our accommodation in the town until such time as the station quarters were ready for habitation.

There are two main " roads " in the township, which extend for about two miles, the houses dotted here and there apparently wherever their owners' fancy dictated. Each house possesses a garden, in which is grown potatoes and such other vegetables (principally root crops) as can be persuaded to endure the climate. Hens and chickens wander about



A PLEASANT EXPRESSION FOR THE BENEFIT OF THE PHOTOGRAPHER.

SEAL PUPS ON THE SHORE.

the roads at leisure, and carry out a systematic survey of the gutters in the hope of supplementing their rations.

On the day following our arrival we were taken to the wireless station in the Government launch, and landed at a crazy wooden jetty about a quarter of a mile

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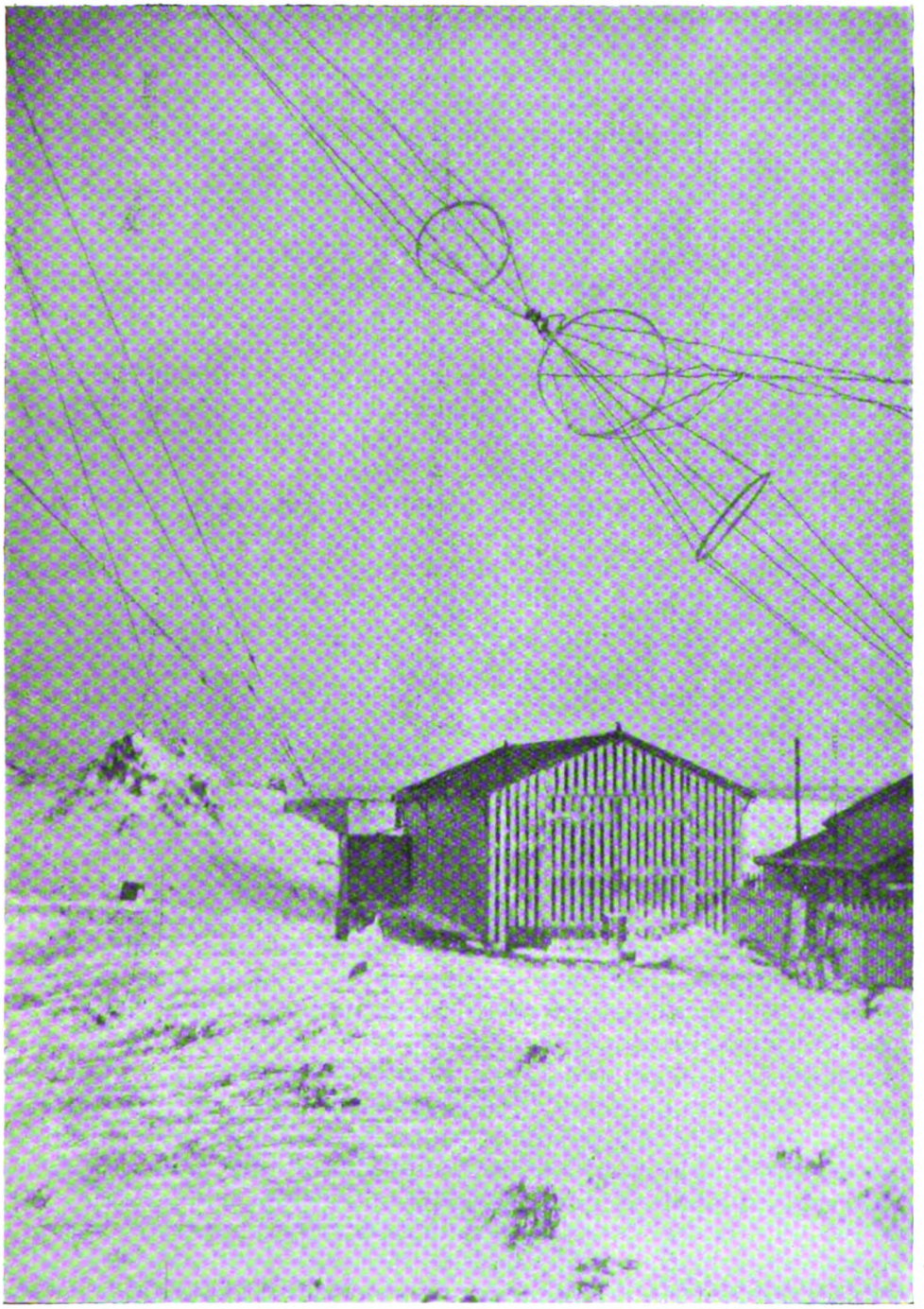

A PORTION OF THE AERIAL WHICH WAS WRECKED IN A BLIZZARD.

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from the site. Arrived at the station we made tests with the departed mail steamer, and then proceeded to inspect our surroundings. The station power-house was a corrugated iron building lined with wood, and consists of an engine room, store room, and operating room. The quarters provided was a wooden bungalow of six rooms built up on piles over a peat bog. The water supply consisted of two large tanks to collect rainwater from the roof, but these were not erected until some time after our arrival. The quarters were not ready for four weeks, so we had the pleasure of walking to and from the station each day. It is when one begins walking that it is realised what sort of proposition one is up against. The "Camp," as it is called, is pure unadulterated country, and consists of a succession of bog pools dotted with irregular tufts of coarse grass. "Walking" really means jumping from one tuft to another to avoid wading through the ponds, and when one has to do a succession of jumps and get a balance on each tuft before hopping off at a tangent for the next hump, one really begins to realise that it is no holiday. After "walking" to town one feels as though it is about six or eight miles, especially in view of the necessity of carrying or (usually) wearing an oilskin.

The climatic conditions do not lack variety. Rain averages 250 days in the year, high winds at least 150, snow, hail and frost at frequent intervals, and sunshine about five days per annum. From these details it will be seen that, being only 365 days in the year, some days had more than their usual share of bad weather. It usually had to either blow and rain together, or otherwise some equally unpleasant combination.

We were duly installed in the quarters, and then had to wait for rain to come in order to be provided with liquid. Under any normal circumstances it would rain immediately, but contrary to our expectations it did not rain for some days, so we were forced to collect water from a hole dug in the ground. As this water filtered through peat it was very richly illuminated dark brown, and with which we were obliged to be content. Of course, as usual, when rain did come it didn't seem to know how to stop.

As previously mentioned, walking is not exactly delightful, and in order to extract some pleasure from this exercise one needs a stout pair of boots and a gun or camera. The gun enables one to bring home a brace of ducks or geese with which to enliven the festive board, and also forms a welcome change from "365" (local name for mutton, signifying every day of the year).

Shortly after our arrival the monotony of the life was broken by a shipwreck only four miles from the station. The vessel was the Pacific liner *Oravia*, outward bound. Fortunately no lives were lost, although the work of rescue was carried out throughout under very trying weather conditions. The problem of finding accommodation for the 600 passengers and crew in the town was no light one, and the survivors were glad of beds made up on floors wherever room could be spared. The two ship's operators were more fortunate, finding quarters on the wireless station, and they were also able to give valuable assistance in dealing with the pressure of work. Communication was established with another vessel of the same line which put into Stanley, and took some two hundred refugees away, the remainder waiting for another relief ship.

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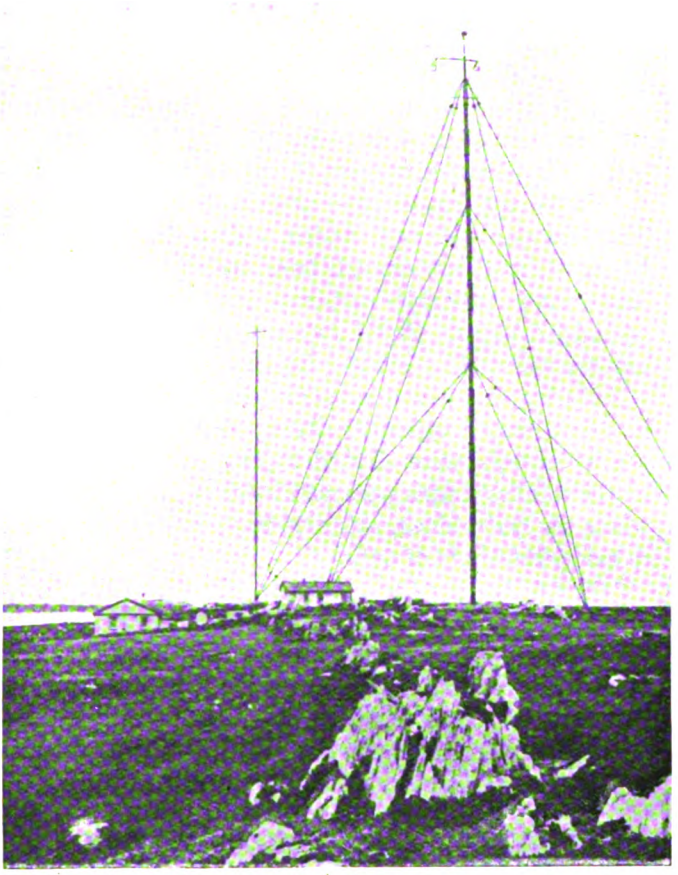
From that time onwards we pursued the usual routine of the station without anything exceptional occurring until the outbreak of war.

The war came as no sudden surprise, as by wireless we were kept in very close touch with the trend of events in Europe. Being a British colony, precautions had to be taken against attack, so the local Volunteer force was mobilised, forming perhaps one of the smallest forces in existence. A call for volunteers was sent to the surrounding islands, and reinforcements gradually came in.



THE TWO STEEL MASTS AND STATION BUILDINGS.

Early in October the gallant Admiral Cradock with his squadron visited Port Stanley, and left shortly afterwards. Upon Admiral Cradock's advice the women and children were sent away from Stanley to the outlying settlements. The exodus was such that local transport facilities could not stand up to, and every possible means of transport was resorted to. My wife had the unpleasant experience of spending the night on the tiny bridge of a steam whaler swept by seas every few moments. Thirty women were on board and perforce had to remain on deck throughout a bitter night. I observed another schooner being towed which was rolling terribly. In this case the women were battened below, and even the sailors on board were sea-sick.

Others preferred to go on horseback, and I am inclined to think they had the better bargain.

The duties at the wireless station were very arduous, all traffic having to go to Monte Video, 1,030 miles away. Messages totalling about 2,000 words in one night were often dealt with.

Fortunately for us the enemy delayed their appearance through various causes until December 8th, arriving off the islands just eighteen hours after the squadron

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commanded by Admiral Sturdee. The consequences are sufficiently well known, the Germans suffering up to that time the greatest naval disaster of the war. (A full account of the battle appeared in our March, 1915, issue.—ED.)

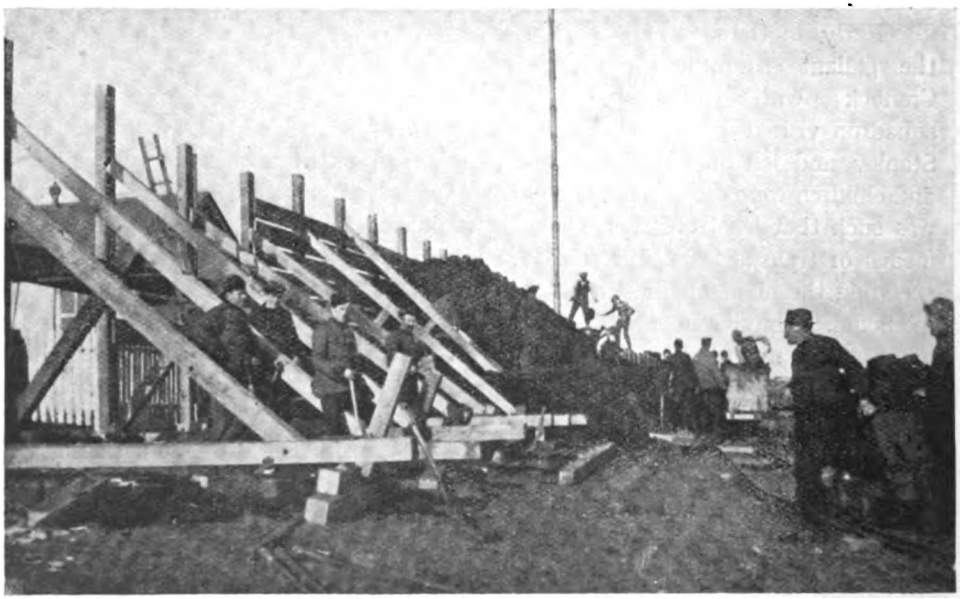
After the battle we looked for some relaxation from such arduous duties as we had been doing, but owing to the British squadron remaining in the vicinity to hunt the *Dresden* we were obliged to keep the watches as before.

While the women were absent we were obliged to mess with the Volunteers. The fare was not very varied, but certainly had novelty. Mutton chops for breakfast, roast mutton and bread for dinner, and cold mutton for tea. No vegetables were obtainable—not even potatoes. Sometimes as a luxury we were served with dried beans. Owing to a shortage of sugar we were reduced to sweetening our tea with golden syrup. Tinned or fresh milk was not obtainable.

During this period we suffered the loss of eight men, whose duty took them in a punt which capsized. After the *Dresden* was accounted for, the majority of the Volunteers were allowed to resume their civil employment, but the watches on the wireless station were not diminished in any way. Fortunately a local operator, whom we had trained, was able to take a regular watch, which greatly assisted in reducing the hours of duty.

Before leaving the Falklands, Admiral Sturdee wrote in the following terms of the work carried out by the station :

"I have the honour to inform Your Excellency that the W/T Station at Port Stanley has been absolutely invaluable to the squadron during its stay in the Falkland Islands. The work was most efficiently carried out under great difficulties, due to atmospheric conditions, the comparatively low power of the station, and the distance to be covered—namely, 1,010 miles to Monte Video."



PREPARING TO PROTECT THE STATION AGAINST ENEMY BOMBARDMENT.

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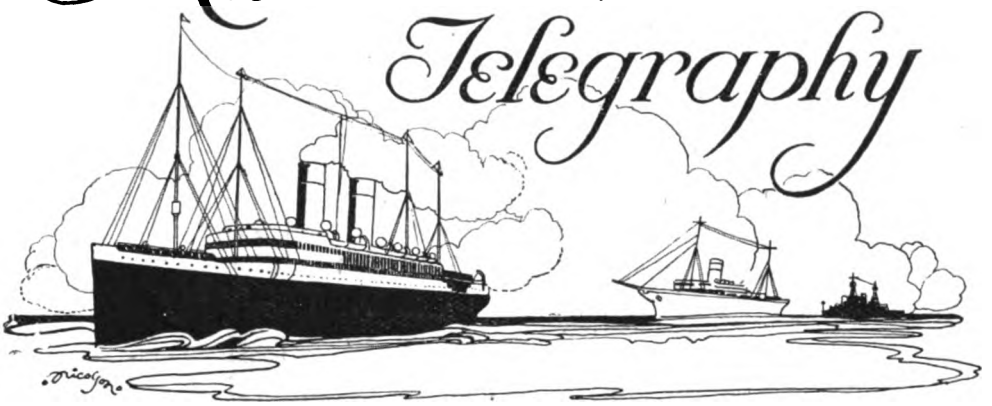
Maritime Wireless Telegraphy



Danish and Swedish Activities.

Amongst the various problems which will face British shipbuilders and steamship owners at the close of the war is the impetus given to the constructional and shipping activities of the various Scandinavian countries. The twin-screw motor-vessel *Peru*, possessing a gross tonnage of 5,584, is the twentieth motor-ship of this description launched from the yard of Messrs. Burmeister & Wain, of Copenhagen, for the East Asiatic Steamship Co., of the same city. The Marconi wireless installation consists of an aerial of the standard steamer pattern, with a " lead " down to the radio room situated amidships at the top of the boat deck. Our illustration of this vessel (on the following page) we owe to the courtesy of *Engineering*, which also publishes complete drawings of the ship and machinery.

Denmark is very far from being alone in the new and rapidly progressing field of motor ship construction, for Swedish yards also are busy, and have recently turned out the *Hamlet*, whose builders claim her to be one of the best-equipped vessels of her type, and which includes amongst her fitments a complete wireless installation. This vessel, with a capacity of 6,800 tonnage and of 5,093 gross, has been engined with two-cycle Diesel machines, totalling 4,700 h.p.

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A Notable British Transport.

The *Queen*, recently reported sunk by German destroyers on October 27th, during their recent dash upon our Channel communications, was one of the best-known boats of the Channel service and the property of the South-Eastern and Chatham Railway. A vessel of abnormal speed, she was equipped with a wireless installation and fitted with turbine engines. The *Queen* was the first steamer so engined to be placed on the Dover-Calais service. By a curious coincidence, it was two years and one day since she had answered a wireless call and succeeded in rescuing 2,500 Belgian refugees, passengers on board the *Amiral Ganteaume*, which, with characteristic barbarity, the enemy had torpedoed. And now the *Queen* has herself fallen a victim to Teutonic violence. It is an open secret that she had proved herself one of the most valuable transports plying between Great Britain and the Continent, and we all feel it to be a matter of congratulation that, at the time when the enemy sank her, she was without the valuable human freight so often and so safely entrusted to her care.

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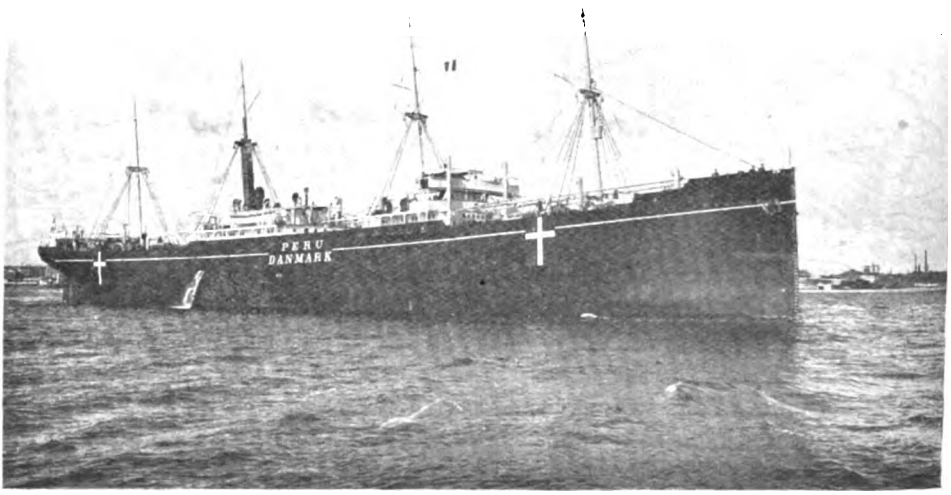

A NEW DANISH MOTOR SHIP.

TWO DONALDSON-LINE VICTIMS.

Amongst the too numerous victims of German submarine piracy which have been recorded in recent days mention must be made of the s.s. *Cabotia*, belonging to the Donaldson Line. She was reported sunk at the end of October, and, at the time of going to press, two boats laden with her officers and crew had not been heard of. She was fitted with a wireless installation, and amongst the list recently published of the persons who it is feared have perished in consequence of her sinking is Mr. Henry, the senior Marconi operator, of whom a notice will be found on page 719.

Survivors from yet a further Donaldson-Line victim were landed on the last day of October at Cork. We refer to the *Marina*, which was sunk without warning by a German submarine on the previous Saturday, and has attracted more than usual attention on account of the fact that it contained a number of American citizens, six of whom lost their lives, whilst two were injured. It would appear that, either two torpedoes successively found their target in the ill-fated ship, or else that the explosion caused by one torpedo resulted in the blowing up of the boilers In consequence of the double explosion the ship broke in two. The two wireless operators, following the Marconi tradition, stuck to their posts until they were ordered to leave, with the result that the junior telegraphist lost his life.

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THE "FRANCONIA" AND

Since we went to press with our last numbe
two fine Cunard steamers, *Franconia* and *Al*
Hunter & Richardson, Ltd., has ever since h
remained one of the most popular vessels on

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a tonnage of 18,150 gross, she was from the start fitted with a [illegible] wireless installation, the highest power carried by British mail steamers at that time, which enabled her to be of considerable assistance at various times to ships [illegible] the North Atlantic route and which has resulted in her attaining at times quite remarkable long-distance transmission. She was at the time of her destruction employed in the Mediterranean on Government transport service [illegible] on that occasion no troops were being carried.

The *Alaunia* was engaged in the Canard [illegible] trade [illegible] tons, fitted with wireless, she was capable in [illegible] accommodation for 2,140 passengers. The passengers about [illegible] number, included a substantial percentage of women and children, were landed [illegible] captain and his crew, numbering 164 in all.

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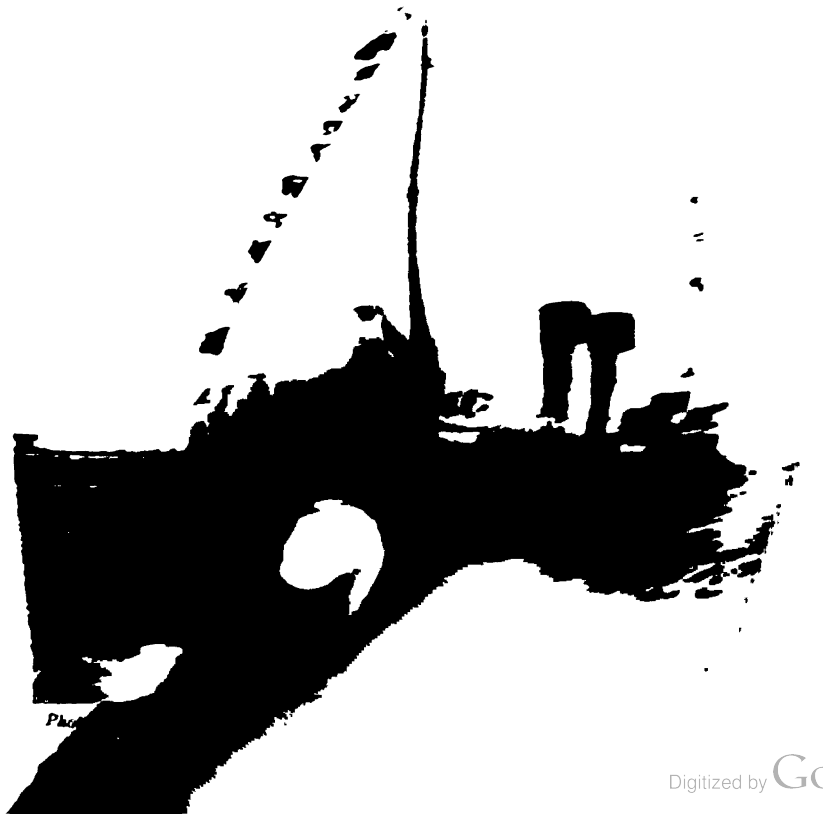
Radio Indispensability Exemplified

As a general rule it may be confidently asserted that [illegible] the carrying of wireless adds immeasurably to the [illegible] rescued; indeed, we have heard it said by an experienced master that he would rather travel without lifeboats than without wireless. [illegible] the past few weeks a long list of German submarine [illegible] of those in which loss of life has occurred were [illegible] apparatus. The United States steamer *[illegible]*



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American nationality, "stood by" a Norwegian steamer, for the purpose of picking up the crew, might have been able to notify other vessels for a considerable distance of what was going on, and might have stood a good chance of being rescued from the fate which subsequently overtook her.

* * * * * *

What happens when no wireless installation is carried, may be illustrated from a case where the torpedo launched from the submarine caused an explosion which smashed the wireless apparatus and put the vessel in the position she would have occupied had no radio been installed. This occurred in the case of the liner *Gallia*, which with about 2,000 French and Serbian soldiers on board was recently sunk by a submarine. This was the well-known French triple-screw steamer, built in 1913 and owned by the Cie. de Navigation sud Atlantique of Paris. She was 14,966 tons burden, and possessed a speed of twenty knots. The number of men saved out of the 2,000 was 1,362. The destruction of the wireless resulted in her being isolated, so that it was not until a French cruiser came across rafts and boats with survivors from the wreck that patrol vessels were despatched to the rescue.

Transpacific Wireless

FURTHER IMPORTANT DEVELOPMENTS.

AN interesting sequel is announced to the recent establishment of wireless intercommunication between Japan and the United States.

The Japanese Government and the Marconi Wireless Telegraph Company of America will inaugurate on Thursday next a commercial "wireless" service between California, Honolulu, and Japan. This service will offer considerable reductions upon the existing cable rates. The new Trans-Pacific tariff will be 80 cents (3s. 4d.) per word full rate, and 40 cents (1s. 8d.) deferred plain language rate, as compared with a cable rate of 1.21 dollars (5s. 0½d.).

The benefit of this new service will be extended and placed at the disposal of all countries, including the United Kingdom, so soon as arrangements can be made.

The departure affords additional proof of the usefulness of trans-oceanic wireless communication as a means for reducing telegraphic rates.

It is hoped eventually to make the new "wireless" route available for Far Eastern telegraphic correspondence.

Two Notes from New Zealand

THE Auckland wireless station, which has been closed since May, 1915, has been reopened.

The Government has decided to erect a wireless station at Rarotonga, which will constitute another link in the Empire, as many islands in the Pacific, such as Samoa and Fiji, will be brought into closer touch with New Zealand, and consequently with other portions of the Empire. The work will be carried out by the Post and Telegraph Department.

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NOTES OF THE MONTH

Wireless on L.33.

Thanks to the completeness of the investigations carried out by Government and other experts into the construction and equipment of L.33, brought down in Essex on September 23rd, Germany's new Super-Zeppelins hold no secrets for us. In view of the detailed attention which these investigations have received in the general Press, we have thought it unnecessary to publish special particulars ourselves. Such of our readers as desire to have a record of the evolution and construction of modern Zeppelins, we would refer to our esteemed contemporary *Flight*, whose issue of October 26th contains a very complete account, profusely illustrated with specially drawn diagrams. As far as the wireless installations are concerned, it would appear that the operator's cabin is located in the forward gondola, just aft of the commander's room, and that generators for electric current capable of being used either for wireless or other purposes are attached to each of the six engines, located in the four or five gondolas, with which each of this newest type of Zeppelins seems to be equipped. The total weight of the radio equipment and the various instruments carried has been calculated to amount to three tons.

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Wireless in the Services.

In our last issue we published, under the title of "Naval and Military Wireless Telegraphists," an account of the status and conditions of training affecting radio men in the shore Services of his Majesty's fighting forces. This article has already brought us a number of inquiries for further particulars, and we understand that the wireless station of the Royal Engineers desires it to be known that they have vacancies for a number of electricians and instrument repairers with good practical knowledge. These men will be engaged for the period of the war only, and applications for enlistment, stating qualifications, should be forwarded to the Commanding Officer, Wireless Training Centre, Worcester. As notified in last month's article, men will be required to enlist as sappers in the Royal Engineers' Wireless Section, but will be given opportunities for early promotion.

This is the situation at the time we go to press; but such requirements as the above often become satisfied quite rapidly, and it is impossible for a monthly publication to keep its readers posted up to date with *the passing needs* of the War Office. We would recommend any young men who are interested in wireless telegraphy to search the daily Press for such announcements as we have above referred to.

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Treatment of Neutral Powers.

The contrast between British and German methods of treating Neutral Powers has been strikingly exemplified in the recent submarine action of our enemies off

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the American coast. In September, 1914, objection was taken by Washington to the action of our own warships in *wirelessing for supplies and newspapers* to the American coast. The sensitive Washington authorities saw in this action a sort of suggestion of violated neutrality! *Their* view was that this might possibly be construed as a utilisation of the American coast for a base of operations. Representations to this effect having been made, Viscount Grey caused instructions to be given to British vessels to meet the United States' views as far as possible, and from that date British warships ceased patrolling near the American coast. The Germans sent their U.53 across the Atlantic, utilised American neutral waters as a harbour of refuge, and induced the Americans to afford them facilities for taking in supplies *directly*, and not as a result of wireless instructions. Then they obtained from newspapers and other shore sources information which enabled them to ascertain the movements of vessels and pick their choice of targets for their torpedoes. They signalised their gratitude for these facilities by destroying vessels on their way to the shores whose hospitality they had just received, thus causing most serious loss and damage to their American hosts.

* * * * * *

A RECLUSE.

There recently died at his house, "Atherton," Sydenham Road, Croydon, Mr. D. H. G. Chambers, who appears to have spent the whole of his latter days in conducting investigations into radio-telegraphy and aerial navigation behind the iron bars which secluded his house. His sister, Miss J. M. Chambers, B.Sc., shared his labours until her death, which occurred four years ago. Mr. Chambers was a recluse of the most uncompromising type; he screened all his basement and semi-basement windows with iron bars strongly cemented in. All the inner doors were bolted or padlocked and the windows screwed up. The door was kept on the chain whenever he opened it, and no one was allowed to enter, except a crossing-sweeper from the adjacent street corner, who executed occasional errands for him, when he was himself too unwell to perform them.

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EXAMINATIONS AND TEXT-BOOKS.

Our attention has been drawn by our contemporary *Electricity* to the contrast between the excellence of the various electrical examinations conducted by the City and Guilds of London Institute, and the lists of books of reference given in the "Programme" of the Institute under the syllabus of each subject. Some of the volumes recommended would appear to be unobtainable, having been out of print for some years; whilst others are out of date. We understand that our contemporary has requested its readers to inform the Editor of such volumes as they have in practice found useful in the course of preparing for electrical examinations, and at the same time to state the grade for which they worked. The Editor of *Electricity* purposes collating and examining the suggestions thus made, and from them he intends to compile representative lists, which should certainly prove both interesting and useful. Doubtless many readers of the WIRELESS WORLD will take an interest in this undertaking; and any who do so may care to communicate with our contemporary at 36 Maiden Lane, Strand, London, W.C.

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The Professor Goes to Sea

Some more Achievements of Professor Sparkington Gapp

By P. W. HARRIS

"WIRELESS telegraphy," said the night-watchman, knocking out his pipe on an empty packing-case, "wireless telegraphy is what you might call——"

"Thank you," I interrupted, "that is enough; this is not a Jacobs story. What *I* want to know is, where is Professor Sparkington Gapp's steam yacht?"

"D'you mean old chin whiskers?"

"If you are referring to my friend's patriarchal beard," I replied with some show of dignity, "it is true that to a vulgar mind such a name might appear suitable."

"Oh! his old tub is round the corner by that further derrick," replied the old salt. "It is in the dry dock."

"Thank you," I said, and passed on.

"You notice I said it is in the *dry* dock," the night-watchman shouted after me when I had progressed a few yards.

"What of it?" I queried.

"Nothing, except it is not the only thing that's dry round here."

But not to be caught by this futile attempt to be funny, I proceeded on my way, followed by a string of personal remarks regarding my face, feet and form.

Two days before I had received from my old friend Professor Sparkington Gapp a note begging me to accompany him on a short sea voyage on his new yacht the S.Y. *Ether Wave*. The invitation indicated the dock in which the vessel was to be found, but the present censorship prohibits my divulging the exact locality.

Although nothing had been mentioned in the professor's brief communication, I knew that for some months past he had been engaged upon important research work for a Government department, and I had no doubt that this invitation would enable me to see some of the most recent inventions of this learned gentleman, particularly in the realms of ether waves and wireless telegraphy.

In what little light remained on this autumn evening I could just observe the outline of the graceful yacht, differing little from those palatial vessels which we are accustomed to associate with American millionaires, munition makers and milk vendors. The only point of difference which I could distinguish was that the masts were inordinately high.

At the foot of the gangway my old friend, dressed in the uniform of a naval lieutenant, approached me with extended hand.

"You are just in time," he exclaimed, as I grasped the proffered palm. "Steam is up, and I hope to leave within a quarter of an hour. Meanwhile I will show you round the vessel."

As is usual on all vessels associated with the British Navy, all the metalwork

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gleamed and shone, and it would have been possible to eat one's food from the snow-white decks. In point of fact a number of the crew were actually disposing of fish and chips in this manner. With admiration I gazed upon the rows of gleaming binnacles, the rolls of hose-pipe and the boxes of sheet anchors.

In due course my friend led me to the saloon, in which I saw all preparations for a sumptuous meal.

As soon as I had disposed of the first seven courses and imbibed the necessary quantity of refreshment, I ventured to enquire of the professor just what was our mission for this voyage.

"Hush!" said Professor Gapp, holding up a warning finger, "that I cannot divulge until we are away from the shore. Let me see, we are due to start in two minutes," he continued, consulting his watch. "The Chief Officer has orders to cut the strings that tie us up immediately the clock strikes the half-hour."

As the professor ceased speaking, a deep boom from the deck's side announced the time for which we were waiting, and a loud snapping noise accompanied by a thrill through the vessel acquainted me with the fact that we were on the move.

"Now come on deck," requested the professor, "and I will outline to you our little plan. First of all let me tell you that although we have to a large extent conquered the German submarine menace, yet there are still one or two of these evil craft which give us a little trouble. This vessel," went on the professor, his countenance suffused with pride, "is equipped with every modern convenience and many pieces of apparatus which I think I may describe without undue pride as ingenious. Some, indeed, I have specially devised for this voyage, and I hope you will have the opportunity of seeing them tried for the first time."

"THE CREW . . . WENT INTO PAROXYSMS OF ANGUISH AND FEAR."

The number of streaks of light which continued to whiz by us afforded me some bewilderment, and I turned to the professor for an explanation.

"Those are the lights of passing ships," he explained. "We are now out in the Channel, you know."

"They must be going very fast," I said.

"Oh, no," replied the professor airily, "not at all; in fact, most of them are at anchor. It is we who are going fast, some 80 knots or so."

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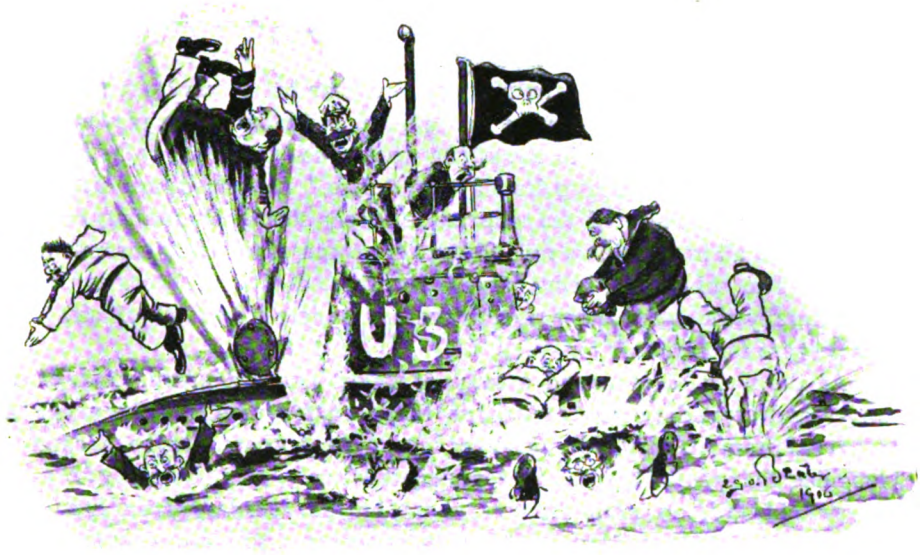

"THE GERMANS, SEEING NO HOPE OF SALVATION, PLUNGED INTO THE WATER."

"Good gracious," I said, "there is no vibration or noise to indicate we are moving at that speed."

"No," answered the famous scientist, "I have balanced all that out by means of capacity and inductance. In this way, of course, I have been able to increase the knottage."

"Capacity and inductance are usually calculated by Nottage, are they not?" I next asked, seeming to recollect something familiar in his words.

"Precisely," was the reply. "Now if you will stand aside, I shall be able to show you one of the most important drills which the crew has had to practise each day. It has been my endeavour to create in the crew under my command a perfect simulation of fear. The purpose of this you will see later on."

And now, to the accompaniment of a tune piped by the bo'sun, the crew, who had previously been lying on deck, went into paroxysms of anguish and fear, some kneeling to say their prayers, others wringing their hands in a way pitiful to see.

"Most excellently done," I remarked. "How did you manage to achieve such a result?"

"Quite simple," replied the professor, "each member of the crew is allowed 6d. per day with which to visit the picture palace approved by his superior officers. By careful study of films of the wild and woolly west variety most of the men were able to reach the present high stage of perfection in a fortnight.

Highly interested, but still mystified as to the purpose to which such a drill could be turned, I next espied, in the centre of the ship, a large deck structure from which came a sharp hum similar to that heard in the vicinity of a large transformer.

"It is by means of that instrument," explained Professor Gapp, "that we are able to cause the submarines to rise to the surface. I have reason to believe that

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one enemy craft is lurking beneath the surface within a mile of where we are situated at present. Bo'sun," ejaculated my friend, "tie this gentleman's knees together, their rattling prevents me hearing myself speak."

An alert seaman jumped from his station near by to carry out the professor's order, although I regret to say he had quite misunderstood the movements of my legs, which were solely due to the strong wind which happened to be blowing.

"From the concealed poles of this device," continued my friend, "there radiates in the vicinity of the ship an intensely strong alternating current field which causes all iron within a mile to heat by reason of the eddy currents generated therein. The submarine, being largely constructed of iron, becomes warmed up and naturally the commander rises to the surface to get a breath of air. We will now prepare for action."

At the word of command a score of sailors unrolled many yards of painted canvas and erected wooden screens, so that in a few moments the yacht became converted from its palatial splendour into what appeared to be a cargo tramp ploughing the seas at a speed of some eight knots. Next, stepping to a controlling switchboard, the professor pressed the button, whereupon the hum from the large structure increased some tenfold in intensity. And sure enough within one hundred yards from our bow the periscope of a submarine rose through the waves, to be followed by the dark superstructure of the well-known enemy craft. Once more a sharp order was given, and the crew, perfect by their long practice, commenced to show every evidence of acute fear and anguish. Sailors dressed as firemen and stokers ran out from various doors, howling for mercy and beating their heads with open palms.

A dark figure now appeared in the moonlight upon the deck of the submarine and placed a large megaphone to its mouth.

"You must shtop was," came the bellowing voice.

"I am stopped is," replied the professor through a still larger megaphone.

"Then I upon your ship coming am," answered the submarine commander in a tone of authority.

"Good was," replied the professor, speaking the dialect perfectly.

A small boat now put off, approaching our side, bearing in it the commander, two officers, and a commercial traveller. An obedient but still trembling crew assisted the Germans up the companion ladder. The commander of the submarine upon reaching deck raised himself to his full height (five feet three).

"I the commander of submarine am," explained the German. "You English dog are. Your ship I sink must."

"That is very kind of you," answered the professor, "but (indicating the commercial traveller) who is this gentleman?"

"I sell lifebelts do," explained the greasy German, smiling affably and producing from a black bag a number of devices marked in large letters, "D.R.P., made in Nuremburg." "This one four shillings value is. Perhaps we can make some beesness."

"Ah, yes," said the professor smilingly and winking at me over his shoulder, "please step down to my cabin. I have much money there, and we complete the business will." The professor and I thereupon marched off, followed by the German

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officers and the commercial traveller, whose smile spread across the whole width of the ship. Upon reaching the bottom of the opening outside the saloon the professor opened the door and, politely allowing the Germans to precede him, promptly locked it again.

"I WILL NOT YOUR BOAT UPGEBLOW!"

"That settles them," said the professor as we remounted the deck. "We will now finish their boat."

Proceeding to the switchboard, the professor pushed two more buttons. "That intensifies the eddy currents," remarked the professor; "300 kilowatts are now being used. If you will watch the craft you will see some interesting events."

Assisted by a pair of binoculars I concentrated my eyes on the half-submerged submarine, which soon became suffused with a pink glow as the eddy currents made it red-hot. Fourteen other Germans came running out of the conning tower and commenced to dance along the decks of the incandescent craft, and then, seeing no hope of salvation, plunged into the waters which were now furiously boiling for many yards around the submarine. Then, with a violent explosion caused by the torpedoes, the submarine disappeared beneath the waves. "Result No. 1," said the professor smilingly.

Below we could hear a furious battering on the door of the room in which the German commander and his confederates were in prison, and a loud and squeaky voice through the keyhole announced to the world at large that the price of lifebelts would now be reduced to 2s. 3½d. (5 per cent. discount for cash). However, we took no notice of this slight disturbance, and orders were given to go full speed upon our way.

In an hour or two we reached a secluded spot off the coast of ——, where the professor announced to me that a second submarine was known to be lurking. Again the ship was disguised, and once more the eddy currents were used to bring the under-sea pirate to the surface. For the second time we were hailed, and in due course the German commander set off in a boat to row over and inform us of our fate. This time, knowing that we should be quite safe, I watched every proceeding with interest. Suddenly, to our surprise and horror, a white-faced and perspiring electrician rushed to the professor's side, and announced that the eddy-current apparatus had broken down. Here was a pretty state of affairs!

"Dear me," said the professor as the electrician explained the disaster, "that is very annoying. However, I think we shall be able to overcome the difficulty."

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In a few moments we were boarded by a German officer, who explained his mission and our relation to the canine tribe, and once more the professor was all politeness. Not only was he polite, but he also explained to the officer in voluble German that his sympathies were all with Germany and her allies. "In fact," said the professor, patting the German commander on the back, "if you wish any proof of how much I love your dear fatherland, please come below and I will show you my collection of valuable German sausages which I have provided for myself and all the crew."

At the sound of the word "sausages" the commander's heart softened, and followed by his lieutenants, he proceeded below. In a few moments the party returned, their arms, pockets and hats full of some splendid specimens of this particular form of nourishment.

"As you good friend of Germany are, and as you sausages provided have, I will not your boat upgeblow."

With these words and with every endeavour not to drop a single sausage, the Germans returned to the submarine, entered the conning tower and closed the hatches.

Wiping the perspiration from my forehead, I turned to the professor with a sigh of relief. "That was a very narrow squeak," I said.

"Yes, perhaps it was," replied my friend, "but the fun is only about to commence. Each of those sausages has a time fuse, and is filled with high explosive. They will not wait long before commencing to eat them, and——"

But before the professor could say any more a mighty explosion rent the air, and pieces of German submarine and sausage skin fell, like a hailstorm, upon our gleaming decks.

"Result No. 2," said the professor. "We will now return to port."

In a few minutes more we were tied up alongside the quay at ——, all filled with a sense of lively satisfaction and a knowledge of duty done.

American Boys' Brigades

MOBILISING WIRELESS ENTHUSIASTS.

WITH the idea of mobilising the wireless and signal enthusiasts of Brooklyn, Queens and Nassau Counties in the State of New York, there has been organised the Signal Corps Regiment of the New York Division of the United Boys' Brigades of America. Besides individual stations of amateur members, the regiment possesses equipment consisting of field wireless telephones and buzzer carts and the necessary equipment for flag-wagging and semaphore signalling. At prearranged times signals and military messages are exchanged between stations, a system which will teach the requirements of military work much better than the usual inconsequential talk that amateurs generally send through the air. Alternating with social meetings of the various units are others where lectures and special work on army wireless fill the programme.

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Correspondence

THE following letter, regarding the article in the October issue entitled "A New Abac," has been received from our contributor Mr. Samuel Lowey. We take the opportunity of pointing out that we welcome correspondence of this nature.

October 11th, 1916.

DEAR SIR,—The article by Mr. Baillie in this month's WIRELESS WORLD is very interesting, but certain assumptions have been made which are not always applicable.

If by means of the formula on page 514—viz. $R = \frac{2\pi\sqrt{\mu n \rho}}{10^9 \cdot p}$ the resistance per cm. length (at a frequency of 250,000) of wires 30 S.W.G. (0·0315 cm. diam.) of copper, manganese-copper, and aluminium-bronze, are worked out, and compared with the resistances of the same conductors to steady currents, it will be obvious that the results cannot be correct.

30[s] S.W.G. 0·0315 cm. diam.	Resistance per cm. length (ohms).		Ratio. $\frac{(a)}{(b)}$
	(*a*) *n*—250,000.	(*b*) To steady current.	
Copper	0·00132	0·00221	0·6
Manganese-Copper	0·01008	0·129	0·078
Aluminium-Bronze	0·00352	0·0158	0·222

The error has arisen through the method of calculating the cross-sectional area of the conducting part of the wire.

Multiplying the thickness of the "skin" by the perimeter will give the approximate area, when the perimeter is very large compared with the thickness of "skin."

The depths to which a current of frequency 250,000 will penetrate the conducting materials above mentioned are: copper 0·01322 cm., manganese-copper 0·1010 cm., and aluminium-bronze 0·0354 cm.

In the case of manganese-copper wire 14[s] gauge this penetration reaches to the centre of the wire, so if the skin thickness be multiplied by the perimeter an area is obtained which is equal *to twice the area of the wire itself*, and if the formula first referred to in this letter is applied the resistance will be found one half of what it should be.

The amount of this error changes with the frequency, the specific resistance, and the area of the conductors; with large conductors and for very high frequencies the amount would be small, but enough has been said to demonstrate that the amount of error is such that it cannot in most cases be neglected.

Even assuming the formula to be correct for all cases, it is found in working out from the diagram the example given at end of the article that the result, viz., 0·000052 ohms, does not agree with the result (0·000021 ohms) obtained by using the formula, but that, if the "diameter" scale be used as a "perimeter" scale, the result is then

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roughly correct to the formula, and it would appear that the "diameter" scale may have been so marked in error.

Considerable ingenuity has been displayed in working out the diagram, and it is unfortunate that the formula that it is based on is not universal in its application.

I am, Sir, yours faithfully,

(Signed) SAMUEL LOWEY.

Jutland Battle Awards

IN our August issue we referred to the distinguished part played by radio-telegraphists in the Jutland battle, and since that time a List of Naval Honours has been issued as a supplement to the *London Gazette*, in which figure the names of officers and men who distinguished themselves on that occasion in radio service. The chief of them is Commander R. L. Nicholson, who "controlled the "wireless telegraph work with great coolness and most marked efficiency, and "reaped the reward of the excellent organisation for which he is responsible." Then we have Lieutenant.-Commander G. C. Candy, recommended for promotion to Commander for "work in connection with the wireless telegraphy of the squadron."

Captain R. C. S. Waller, R.M.L.I., was recommended for promotion on the grounds that he "has been in charge of the wireless organisation of a battle squadron "since the beginning of hostilities. This squadron was composed of new ships of "various types which had been hurriedly completed, and the work entailed in "bringing the wireless installation of vessels designed for foreign Powers into working "order was carried out by him entirely satisfactorily."

Amongst those on the lower deck in receipt of awards, Chief Petty Officer Telegraphist P. McEvoy was granted the Conspicuous Gallantry Medal for "working "on deck almost continuously throughout the action. Four times he repaired or "cleared the main aerial under fire in a cool and efficient manner. The smoke on "the mess deck was so intense that he had to feel his way up on deck."

On the promotion list of men belonging to the R.N.V.R. Section we find the name of Warrant Telegraphist S. Lewington, mentioned in despatches as "in charge "of the auxiliary wireless telegraphic cabinet during the whole operations, and "carried out his work with conspicuous coolness and ability."

An earlier *Gazette* (under date of September 7th) announced the awarding of the D.S.O. to Acting-Lieutenant F. S. Lofthouse, R.N.R., for gallantry in the Adriatic on the occasion of the attack upon drifters made by an Austrian cruiser. In view of the danger attached to working the wireless apparatus (always a target for enemy gunfire) he took charge of it himself and continued wirelessing for assistance till his ship was in a sinking condition. Then he had a four-hour swim to an Italian destroyer, and brought her back to the rescue of the six men composing his crew, who had been clinging to the "wireless" mast. This constitutes a most notable feat of courage, athleticism, and endurance.

The Editor takes this opportunity of wishing his readers the Compliments of the Season.

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Some Characteristic Curves of a Poulsen-Arc Generator

By N. W. McLACHLAN, B.Sc.Eng., A.M.I.E.E.

Read 7th September at Newcastle-on-Tyne, before Section G of the British Association.

(*Continued from page* 599, *November issue.*)

EFFICIENCY OF ARC AS A CONVERTER OF DIRECT INTO OSCILLATORY CURRENT.

The efficiency of the arc itself (apart from the loss in the field coils) as a converter of direct current into oscillatory current can be dealt with from two points of view: (1) The efficiency of the arc in respect of the oscillations of fundamental frequency, this being important in wireless telegraphy from the standpoint of radiation from an antenna; (2) the total efficiency, including the energy derived from the oscillations of fundamental frequency and the various harmonics.

The efficiency of the arc was obtained from the formula

$$\% \; e = \frac{100 \text{ (Power absorbed in shunt circuit)}}{(V - IR)I}$$

$$= \frac{100 \; I_s^2 R_s}{(V - IR)I},$$

where I_s = R.M.S. value of shunt current, R_s = total resistance in shunt circuit, V = direct current voltage across the arc and field coils, I = direct current (assumed constant) supplied to generator, and R = resistance of the field coils. The power supplied to the arc from the external circuit is a maximum when $I = \frac{V}{2R}$, *i.e.*, when the power supplied to the arc is equal to the power expended in the field coils. In order to test the accuracy of the denominator in the formula for the efficiency of the arc, the power factor of the arc was measured under working conditions by means of a wattmeter. It was found that the ratio Watts-volt-amperes was nearly unity.*

Thus the power supplied to the arc is given by the expression $(V - IR)I$.

Case 1.—With a given resistance, the efficiency of the arc at any particular frequency increases with the capacity in the shunt circuit.

The curves in Fig. 6 show the total † efficiency of the arc plotted against the frequency for a capacity of 0·00195 mfd., and various values of the resistance. As in Fig. 2, each curve has a maximum ordinate, showing that, with fixed capacity and resistance, there is a certain inductance and therefore frequency, for which the efficiency of the arc is a maximum. This maximum corresponds to the maximum power and current in the shunt circuit under the same conditions.

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* *See* J. A. Fleming, "The Poulsen Arc as a Means of Obtaining Continuous Electrical Oscillations," *The Electrician*, Vol. LIX., p. 614, 1907.

† *See* footnote to Fig. 2.

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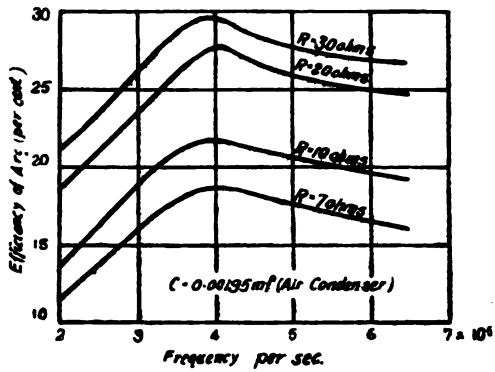

FIG. 6.—CURVES SHOWING THE TOTAL EFFICIENCY OF THE ARC PLOTTED AGAINST THE FREQUENCY FOR VARIOUS VALUES OF THE RESISTANCE IN THE SHUNT CIRCUIT.

Fig. 7 shows the efficiency obtained with various resistances for different values of the frequency and a capacity of 0·00195 mfd. For resistances between 20 and 60 ohms the variation in efficiency is small, but the shape of the curves is such that at a given frequency there is a certain value of the resistance for which the efficiency is a maximum. This resistance, however, is larger than that corresponding to maximum power in the shunt circuit—*i.e.*, the maximum efficiency is obtained when the shunt current is slightly less than that giving maximum power for the given capacity.

It should be mentioned, however, that for given conditions the efficiency depends to a certain extent on the length of the arc, and it is sometimes possible (with large resistances and in general under conditions causing irregular burning) to vary this in such a way that the proportionate alteration in the current through the arc is greater than that in the shunt circuit. By increasing the arc length, with a resistance of about 50 ohms in circuit (capacity=0·00195 mfd.), the direct current supplied to the generator diminished, the efficiency increased, but the burning was very noisy and irregular. Hence a very accurate determination of the efficiency in the case of a hand-operated arc is out of the question. The highest efficiency obtained for oscillations of fundamental frequency was approximately 38 per cent. (capacity 0·00924 mfd.), which indicates that a considerable amount of energy is wasted in heating the electrodes and in creating the arc itself by volatilisation of the copper and graphite, the latter material burning away very rapidly with large currents. Some approximate data bearing on these remarks are given in Table I.

TABLE I.

(MOSCICKI CONDENSERS) OSCILLATIONS OF FUNDAMENTAL FREQUENCY WITH NORMAL MAGNETIC BLAST.

Capacity.	Maximum Power Absorbed in Shunt Circuit.*	Efficiency Corresponding to Maximum Power.	Power Corresponding to Maximum Efficiency.*	Maximum Efficiency of Arc.
Microfarad.	Watts.	Per Cent.	Watts.	Per Cent.
0·00924	220	36	200	38
0·00368	175	26	160	30

TABLE II.

(MOSCICKI CONDENSERS) OSCILLATIONS OF ALL FREQUENCIES WITH NORMAL MAGNETIC BLAST.

Capacity.	Largest Power Absorbed in Shunt Circuit.*	Efficiency Corresponding to Largest Power.	Power Corresponding to Largest Efficiency.*	Largest Efficiency of Arc.
Microfarad.	Watts.	Per cent.	Watts.	Per Cent.
0·00924	280	39	268	42
0·00368	185†	28†	165†	31†

* This does not include the loss in the condensers. The power absorbed in the shunt circuit and the efficiency of the arc will, therefore, be greater than the values given in Tables I. and II.

† These are maximum values.

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Case 2.—In Table II. approximate data are given with reference to the "total" efficiency of the arc. Since the power obtained from any harmonic depends on the square of the root-mean-square value thereof, the power obtained from the harmonics for capacities of 0·00091 mfd. and 0·00195 mfd. was small enough to be neglected. The figures in Table II., therefore, relate to the largest capacities only. It will be seen that the total power and efficiency are larger than the same quantities for oscillations of fundamental frequency, and that they increase with the capacity.

According to Barkhausen,* to obtain the greatest possible efficiency, it is necessary for the voltage to rise very rapidly to the highest possible value after the arc has been extinguished. This is effected by water-cooling the copper electrode and removing the ionised gases quickly, the latter being accomplished by using a magnetic blast or a gas of high diffusion velocity, or both of these. Thus, if the copper electrode in these experiments had been water-cooled, the efficiency of the arc might have been greater than that indicated by the figures in Tables I. and II. and Figs. 6 and 7.

Conclusions.

1. With fixed capacity and frequency there is a certain resistance giving maximum power absorbed in the shunt circuit. There is also a certain resistance for which the efficiency of the arc is a maximum; but the resistance corresponding to maximum power is smaller than that corresponding to maximum efficiency.†.

2. With fixed capacity and fixed resistance in the shunt circuit there is a certain inductance, and therefore frequency, for which the power obtained from oscillations of fundamental frequency is a maximum. For capacities of limited value the total power from oscillations of all frequencies has a maximum value, but for capacities beyond a certain limit there does not appear to be any definite maximum value. The same conclusion applies in connection with the efficiency of the arc, but the resistance corresponding to maximum power is smaller than that corresponding to maximum efficiency.

3. With given resistance and frequency the power obtainable in the shunt circuit (both total power and that due to oscillations of fundamental frequency) and the efficiency of the arc increase with the capacity; but with the larger capacities (of the order of 0·00368 mfd. and upwards) the burning, especially with

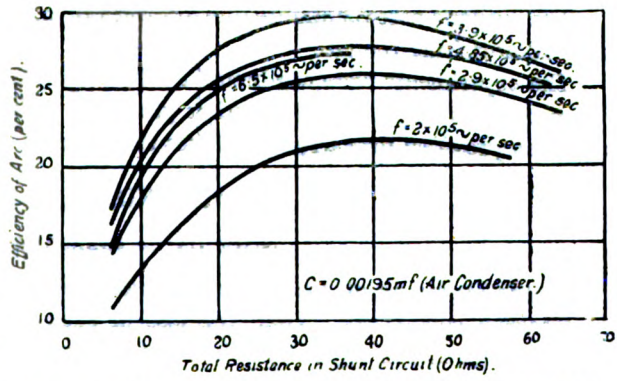

FIG. 7.—CURVES SHOWING THE TOTAL EFFICIENCY OF THE ARC PLOTTED AGAINST THE RESISTANCE IN THE SHUNT CIRCUIT FOR DIFFERENT VALUES OF THE FREQUENCY.

* *See* W. H. Eccles, *Wireless Telegraphy and Telephony*, p. 201; also E. Ruhmer, *Wireless Telephony*, translated by J. Erskine Murray, p. 200.

† Efficiency based on oscillations of fundamental frequency or total efficiency. Both efficiencies occur with the same resistance.

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small inductances, is apt to be irregular and noisy—*i.e.*, when the ratio L/C is small.

4. When the power absorbed in the shunt circuit is very small, the capacity being fixed and not exceeding a certain limit, there is a certain inductance, and therefore frequency, for which the shunt current is a maximum. For capacities beyond a certain limit there does not appear to be any definite maximum value. With diminished blast, the maximum value of the shunt current occurs at a lower frequency than with normal blast, and it is possible to maintain the shunt current approximately constant and the burning regular over a fairly wide range of frequency by suitably varying the strength of the magnetic blast.

5. A diminution in the strength of the magnetic blast does not cause any appreciable alteration in the maximum power and maximum efficiency. The maximum power occurs at a lower frequency, and more power is obtainable at lower frequencies than with a stronger blast. It is possible to keep the power approximately constant and the burning regular over a certain range of frequency by suitably varying the strength of the magnetic blast.

6. A diminution in the strength of the magnetic blast does not cause any appreciable alteration in the fundamental frequency of the oscillations in the shunt circuit; but there is a tendency for the second harmonic to increase with capacities of 0·00368 mfd. and upwards.

7. The most prominent harmonic in the shunt circuit is the second, thereby showing the existence of an asymmetrical current wave. This harmonic for any given capacity increases with decrease in inductance, and therefore increase in frequency. For a given frequency the second harmonic increases with the capacity.

8. The insertion of resistance in the shunt circuit causes the burning to be less regular than it is without resistance. The irregularity of the burning increases with increase in the resistance. At the higher frequencies the burning is more irregular with diminished blast than with normal blast, but at the lower frequencies the reverse is the case. If the blast is diminished beyond a certain limit, the oscillations are irregular.

The author's best thanks are due to Professor E. W. Marchant, D.Sc., for reading over and criticising the MS.

The experiments were conducted in the Applied Electricity Laboratories of the Liverpool University, and the author gratefully acknowledges the facilities which have been provided for carrying out this and other research work.

APPENDIX.

NOTE ON CONDENSERS.

At the beginning of the Paper reference was made to the loss which occurs in the Moscicki condensers. That the loss in such condensers carrying large high-frequency currents is appreciable has been shown by Dr. Fleming and Mr. Dyke.* It is also shown, in the same Paper, that there is a loss with air condensers if the electrostatic force is large enough to cause appreciable ionisation of the air between the plates. In order to ascertain whether the loss in the Moscicki condensers had

* *Proc. Phys. Soc.*, London, Vol. XXIII., p. 117, 1911; also *The Electrician*, Vol. LXVI., p. 658, 1911.

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any considerable effect on the power obtained in the shunt circuit, an air condenser was arranged to have the same capacity at high frequencies as one of the Moscicki condensers. The capacity of the air condenser was adjusted until, with given inductance (comparatively large) and the least resistance possible in the shunt circuit, the same frequency was obtained with each condenser. A sandstone resistance (about 15 ohms) was connected in the shunt circuit and a series of readings of power and frequency taken with each condenser. It was found that the loss in the Moscicki condenser was sufficient to cause a diminution in the power expended in the shunt circuit (as found by voltmeter and ammeter readings), in some cases exceeding 15 per cent.; but this did not invalidate any of the conclusions given above. It was thought more satisfactory, however, to give results, as shown graphically in the diagrams, for an air condenser. The effect of the condenser loss was greatest when the current was largest for the given conditions—*i.e.*, when the sandstone resistance was not in circuit (*see* Fig. 5). In this case the voltage, and therefore the dielectric stress, especially at the lower frequencies, was greater than with resistance in circuit.

The capacity of each condenser was tested at 500~ per second by Carey Forster's method, using a Campbell mutual standard and a Duddell vibration galvanometer. An air condenser was arranged so that the frequency of the oscillations in the shunt circuit was approximately the same as that obtained with a Moscicki condenser. The capacity of the air condenser was then measured at 500~ per second, and its capacity at high frequencies assumed to be equal to this. From this value of the capacity and the frequency of the oscillations obtained with each condenser, the capacity of the Moscicki condenser at high frequencies was calculated.

The capacities of the condensers were then found ballistically by charging up to about 210 volts, using 100 small secondary cells, and discharging through a ballistic galvanometer. The galvanometer was calibrated, using a Weston cadmium cell and a standard mica condenser having a capacity of 1 mfd.

As a check on the method, it was found that an air condenser 0·00175 mfd. had the same capacity when measured both ballistically and at 500~ per second. The results of some of the experiments are given in Table A.

TABLE A.

MOSCICKI CONDENSERS.

Capacity (Microfarad).			Percentage Difference between Capacity at 500~ per Sec. and Ballistically.
Ballistically.	500~ per Sec.	$1{\cdot}75 \times 10^5$~ per Sec.	
0·00354	0·00278	0·00272	21·5
0·00377	0·00295	0·00284	21·7

It is clear that the capacity found with alternating currents is much smaller than that found ballistically, the percentage decrease being almost the same in each case. There is, however, only a comparatively small difference between the capacities at 500~ per second and $1{\cdot}75 \times 10^5$~ per second. The decrease in the measured capacities is doubtless due to diminution in the dielectric coefficient, which occurs with alternating currents of increasing frequency.*

* *See* J. A. Fleming, *The Principles of Electric Wave Telegraphy and Telephony*, pp. 183-186.

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One condenser, thought to be faulty, gave some remarkable results which are tabulated in Table B.

TABLE B.

MOSCICKI CONDENSER.

Capacity (Microfarad).			Percentage Difference between Capacity at 500~ per Sec. and Ballistically.
Ballistically.	500~ per Sec.	2×10^5~ per Sec.	
0·00341	0·00185	0·00173	46

By allowing a short interval of time to elapse between breaking circuit with the charging cells, and making the galvanometer circuit, it was possible to obtain a rough estimate of the relative leak with various condensers. The rate of leak with the condenser in Table B was much larger than that with the other condensers, although the insulation resistance of each condenser, as found by an ohmmeter (using direct current), was "infinite."

The conductance or alternating current conductivity of dielectrics has been thoroughly investigated by Dr. Fleming and Mr. Dyke.* They found that in the case of glass as a dielectric the conductance and the capacity (and therefore the dielectric coefficient) at a given frequency increased with the temperature. At a given temperature the conductance increased but the dielectric decreased with increase in frequency (900 – 5000 ~ per sec.). The extent of the variation in the conductance and dielectric coefficient will, of course, depend on the nature of the glass.

The results in Table A confirm observations made some years ago by Dr. E. W. Marchant, using plate-glass condensers. The conditions were slightly different, since the condensers were charged up to about 9,400 volts by a Wimshurst machine, and then discharged through an oscillatory circuit having a free period of $\frac{1}{100000}$th second. Under these conditions the capacity was 15 per cent. less than that obtained ballistically.

Wireless on the Ranch.

A NOVEL USE FOR RADIOTELEGRAPHY.

THE following paragraph appeared in our American contemporary, *The Electrical Experimenter*, recently. The last sentence is particularly interesting :—

"Major James Ormsby is completing the installation of wireless telegraph plant "at his home in Casper, Wyoming, and at his ranch 50 miles to the north-east. When "the system is in operation he intends to direct his large sheep business by wireless. "The two plants are of sufficient power to receive messages from points up to 700 "miles distant, and the lonely ranch, therefore, will be in constant touch with "Denver, Omaha, Salt Lake, and other cities of the region. The aerials of the Casper "Station are suspended from two poles, each 150 feet high. It seems as if there is "no locality where wireless has not been utilised."

* *Journal I.E.E.*, Vol. XLIX., p. 323, 1912.

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Among the Operators

THE LATE OPERATOR J. HENRY.

LOSS OF THE S.S. "CABOTIA."

THIS vessel, particulars of the loss of which appear under the heading of "Maritime Wireless Telegraphy," carried as senior operator Mr. John Henry and as junior Mr. John Weir Crichton. It is with the deepest regret that we have to inform our readers that Mr. Henry lost his life in the disaster, although fortunately Mr. Crichton was saved.

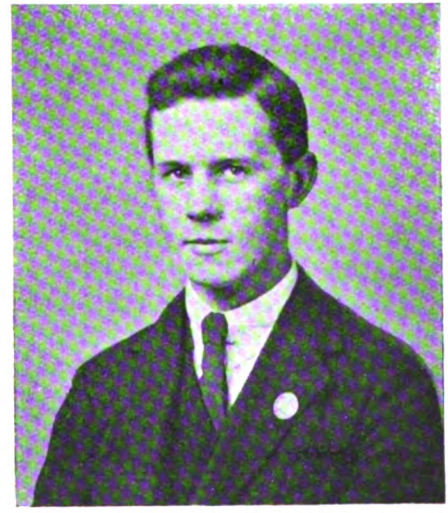
The late senior operator was of Scotch birth, having been born at Newcraighall, Midlothian, on September 26th, 1897. Upon leaving school in Midlothian Mr. Henry took up a position in the mines, and later entered for a course in wireless telegraphy at the North British Wireless School, Edinburgh, where he obtained his first-class certificate. Upon completing his training at the Marconi House School Mr. Henry was appointed to the s.s. *Cabotia* a year ago and remained upon that vessel up to the time of the disaster. We take this opportunity of expressing our sincerest sympathy with the late operator's relatives in their sad bereavement.

The junior operator, Mr. J. W. Crichton, is also of Scotch birth, hailing from Lanark. He is 19 years of age, and also received his preliminary wireless training at the North British Wireless School. Joining the Marconi House School in March of this year, Mr. Crichton completed his training and was only appointed to the *Cabotia* just before she started on her last voyage. We understand that Mr. Crichton was rescued uninjured, and we congratulate him upon his fortunate escape.

* * * * *

SINKING OF THE S.S. "MARINA."

Still another wreck in which a Marconi operator has unfortunately lost his life was that of the s.s. *Marina*, the torpedoing of which figured so prominently in recent newspaper reports. In this case the two operators were Mr. David Murray Sproat, senior, and Mr. David Richmond, junior. Mr. Sproat was fortunately saved after



OPERATOR J. W. CRICHTON.

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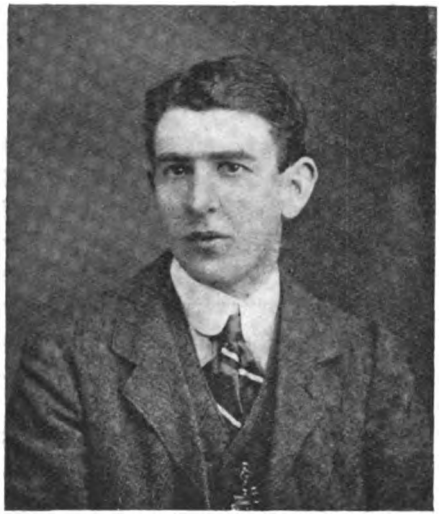

OPERATOR D. M. SPROAT.

some exciting experiences, but it is to be deeply regretted that Mr. Richmond was unable to get away from the ill-fated vessel, his body being washed ashore in Bantry Bay a few days afterwards.

Mr. Sproat, the senior operator, is 26 years of age and was born at Ayr. He was educated at Ayr Grammar School and upon leaving that institution entered the service of the Glasgow and North Western Railway, where he was employed in the telegraphic department. Conceiving an interest in wireless telegraphy, Mr. Sproat took a course of training at the Warrington Wireless Training College, where he obtained his Postmaster-General's First Class Certificate. In 1912 he entered the school at Marconi House, and on completion of his training was appointed to the s.s. *Hydaspes*, from which he transferred to the s.s. *Mendi*. He later served on the s.s. *Elmina*, *Wayfarer*, *City of Marseilles*, for a number of voyages, s.s. *Kastalia*, *Elysia* and *Tritonia*. He was appointed to the s.s. *Marina* in the early part of this year and had sailed for several voyages on this vessel before she met her fate.

Mr. David Richmond who, as above mentioned, has lost his life in the services of his country, was born at Preston in November, 1891. He was educated in Glasgow, and wishing to enter for the career of a wireless telegraphist undertook a course of training at the North British Wireless School, Glasgow. Joining Marconi House School in February of this year, he completed his training and was appointed shortly afterwards to the s.s. *Fremona*, from which he transferred to the *Marina* in May. He had made three voyages before the vessel met with disaster. Deep sympathy is felt with the late Mr. Richmond's relatives in their terrible bereavement.

* * * * *

THE CHASE OF THE S.S. "GLENGYLE."

Many of our readers will have noticed in the daily press an account of the exciting chase by a German submarine of the s.s. *Glengyle*, which succeeded in evading the pirate by clever seamanship. Mr. Thomas Smith, the operator on this vessel, is a native of East Lothian, and is 19 years of age. Prior to entering the Marconi service he was engaged in the post office as a telegraphist, and upon completing his

THE LATE OPERATOR D. RICHMOND.

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OPERATOR T. SMITH.

Kinipple, who is 22 years of age, was born in London and educated at Greenwich. Taking an interest in radiotelegraphy he entered the Marconi House Evening Classes and in due course obtained his Postmaster-General's Certificate. His first appointment was to the s.s. *Sagamore* in June, 1914, and later he sailed on the s.s. *Celtic* and a number of other vessels. Prior to

OPERATOR G. W. SAIL.

training at the Marconi House School was appointed to the s.s. *Pomeranian*. From this ship he transferred to the s.s. *Circassia*, afterwards sailing on the s.s. *Grampian*, *Narragansett*, *Mamari* and *North Point*. He was appointed to the s.s. *Glengyle* in April of this year.

* * * * *

S.S. "ROWANMORE."

Two operators were carried on this vessel, Messrs. O. S. Kinipple and G. W. Sail, both of whom, we understand, have been rescued uninjured. Mr. Oscar Stanley

OPERATOR O. S. KINIPPLE.

joining the ill-fated *Rowanmore* he had made a voyage on the *Clan McNab*.

Mr. William George Sail, junior operator, was born at Highgate in 1897. After leaving school he entered the service of the Midland Railway Company as telephone operator, and in April, 1916, joined the Marconi Company's London School as a learner. After completing a training course he was appointed to the s.s. *Memphian*, and after serving one trip on this vessel transferred to the *Rowanmore*. We congratulate both of these men upon their lucky escape.

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Instructional Article

NEW SERIES (No. 16).

The following series, of which the article below forms the sixteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

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101. In Article XV we proved the following formulæ:

(i) $$\text{Sin } C + \sin D = 2 \sin \frac{C+D}{2} \cos \frac{C-D}{2}$$

(ii) $$\text{Sin } C - \sin D = 2 \cos \frac{C+D}{2} \sin \frac{C-D}{2}$$

(iii) $$\text{Cos } C + \cos D = 2 \cos \frac{C+D}{2} \cos \frac{C-D}{2}$$

(iv) $$\text{Cos } C - \cos D = -2 \sin \frac{C+D}{2} \sin \frac{C-D}{2}$$

or $$\text{Cos } D - \cos C = 2 \sin \frac{C+D}{2} \sin \frac{C-D}{2}$$

These formulæ are best remembered in words, as follows:

(i) The sum of the sines of two angles is equal to twice the sine of half the sum into the cosine of half the difference.

(ii) The difference of the sines equals twice the cosine of half the sum into the sine of half the difference.

(iii) The sum of the cosines equals twice the cosine of half the sum into the cosine of half the difference.

(iv) The difference of the cosines equals twice the sine of half the sum into the sine of half the difference.

In the case of (iv) it must be remembered that by the difference of the cosines of two angles, we mean the cosine of the *smaller* angle *minus* the cosine of the *larger*.

102. We can obtain some more useful formulæ from the $(A+B)$ formulæ as follows:

(*a*) Put A for B in the $(A+B)$ formulæ.

Then $$\sin (A+B) = \sin (A+A)$$
$$= \sin 2A = \sin A \cos A + \cos A \sin A$$

or $$\sin 2A = 2 \sin A \cos A.$$

Also $$\cos 2A = \cos A \cos A - \sin A \sin A$$
$$\cos 2A = \cos^2 A - \sin^2 A$$
$$= \cos^2 A - (1 - \cos^2 A)$$

and $$\cos 2A = 2 \cos^2 A - 1$$

or $$\cos 2A = \cos^2 A - \sin^2 A$$
$$= (1 - \sin^2 A) - \sin^2 A$$

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and $$\cos 2A = 1 - 2\sin^2 A.$$

Lastly, $$\tan 2A = \frac{\tan A + \tan A}{1 - \tan A \tan A}$$

or $$\tan 2A = \frac{2\tan A}{1 - \tan^2 A}.$$

(*b*) Put $\frac{A}{2}$ in place of A in these latter equations:

Then $$\sin 2\left(\frac{A}{2}\right) = \sin A = 2\sin\frac{A}{2}\cdot\cos\frac{A}{2}$$

$$\cos 2\left(\frac{A}{2}\right) = \cos A = \cos^2\frac{A}{2} - \sin^2\frac{A}{2}$$

$$\cos A = 2\cos^2\frac{A}{2} - 1 = 1 - 2\sin^2\frac{A}{2}$$

and $$\tan 2\left(\frac{A}{2}\right) = \tan A = \frac{2\tan\frac{A}{2}}{1 - \tan^2\frac{A}{2}}$$

Examples.

1. Prove $\dfrac{\sin 2\theta + \sin\theta}{\cos 2\theta + \cos\theta} = \tan\dfrac{3\theta}{2}$.

Applying the $(\sin C + \sin D)$ formula to the top line, and the $(\cos C + \cos D)$ formula to the bottom line, we get

$$\frac{2\sin\left(\frac{2\theta+\theta}{2}\right)\cos\left(\frac{2\theta-\theta}{2}\right)}{2\cos\left(\frac{2\theta+\theta}{2}\right)\cos\left(\frac{2\theta-\theta}{2}\right)} = \frac{2\sin\frac{3\theta}{2}\cos\theta}{2\cos\frac{3\theta}{2}\cos\theta}$$

Cancel out $2\cos\theta$ and we have left—

$$\frac{\sin\frac{3\theta}{2}}{\cos\frac{3\theta}{2}} = \tan\frac{3\theta}{2}$$

Q. E. D.

2. Prove $\cos^2 A\,(1 - \tan^2 A) = \cos 2A$

$$\cos^2 A\,(1 - \tan^2 A) = \cos^2 A\left(1 - \frac{\sin^2 A}{\cos^2 A}\right)$$

$$= \cos^2 A - \sin^2 A = \cos 2A.$$

Q. E. D.

3. Prove $$\left(\sin\frac{\theta}{2} - \cos\frac{\theta}{2}\right)^2 = 1 - \sin\theta$$

$$\left(\sin\frac{\theta}{2} - \cos\frac{\theta}{2}\right)^2 = \sin^2\frac{\theta}{2} - 2\sin\frac{\theta}{2}\cos\frac{\theta}{2} + \cos^2\frac{\theta}{2}$$

$$= \left(\sin^2\frac{\theta}{2} + \cos^2\frac{\theta}{2}\right) - 2\sin\frac{\theta}{2}\cos\frac{\theta}{2}$$

$$= 1 - \sin\theta.$$

Q. E. D.

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Examples for Practice.

23. Prove $\cos(60°+A)+\cos(60°-A)=\cos A$.

24. Prove $\dfrac{\sin 2\theta-\sin\theta}{\cos\theta-\cos 2\theta}=\cot\dfrac{3\theta}{2}$.

25. Prove $2\operatorname{cosec} 2A=\sec A \,.\, \operatorname{cosec} A$.

26. Prove $\dfrac{\cot^2 B+1}{\cot^2 B-1}=\sec 2B$.

Solutions to Examples in Article XV.

21. (*a*) $\text{Cos } 75°=\cos(45°+30°)$
$=\cos 45°\cos 30°-\sin 45°\,,\,\sin 30°$
$=\dfrac{1}{\sqrt{2}}\cdot\dfrac{\sqrt{3}}{2}-\dfrac{1}{\sqrt{2}}\cdot\dfrac{1}{2}=0{\cdot}259$ (nearly).

(*b*) $\text{Tan } 75°=\tan(45°+30°)=\dfrac{\tan 45°+\tan 30°}{1-\tan 45°\,.\,\tan 30°}$
$=\dfrac{1+\dfrac{1}{\sqrt{3}}}{1-1\times\dfrac{1}{\sqrt{3}}}=\underline{3{\cdot}73}.$

(*c*) $\text{Sin } 105°=\sin(60°+45°)$
$=\sin 60°\cos 45°+\cos 60°\sin 45°$
$=\dfrac{\sqrt{3}}{2}\cdot\dfrac{1}{\sqrt{2}}+\dfrac{1}{2}\cdot\dfrac{1}{\sqrt{2}}=0{\cdot}966.$

(*d*) $\text{Sec } 195°=\dfrac{1}{\cos 195°}=\dfrac{1}{\cos(135°+60°)}$
$=\dfrac{1}{\cos 135°\cos 60°-\sin 135°\sin 60°}$
$=\dfrac{1}{\left(-\dfrac{1}{\sqrt{2}}\right)\dfrac{1}{2}-\dfrac{1}{\sqrt{2}}\cdot\dfrac{\sqrt{3}}{2}}=\underline{1{\cdot}034}.$

22. (*a*) $\text{Sin } 55°=0{\cdot}82.$
Therefore, $\cos 55°=\sqrt{1-\sin^2 55°}=0{\cdot}57$
$\tan 55°=\dfrac{\sin 55°}{\cos 55°}=\underline{1{\cdot}43}.$
Similarly, from $\cos 20°=0{\cdot}94$, we get
$\sin 20°=0{\cdot}34$
and $\tan 20°=0{\cdot}36.$
Then $\sin 75°=\sin(55°+20°)$
$=\sin 55°\cos 20°+\cos 55°\sin 20°$
$=(0{\cdot}82\times 0{\cdot}94)+(0{\cdot}57\times 0{\cdot}34)=0{\cdot}96.$

(*b*) $\text{Cos } 35°=\cos(55°-20°)$
$=\cos 55°\cos 20°+\sin 55°\sin 20°$
$=0{\cdot}82.$

(*c*) $\text{Tan } 75°=\tan(55°+20°)$
$=\dfrac{\tan 55°+\tan 20°}{1-\tan 55°\tan 20°}$
$=\underline{3{\cdot}73}.$

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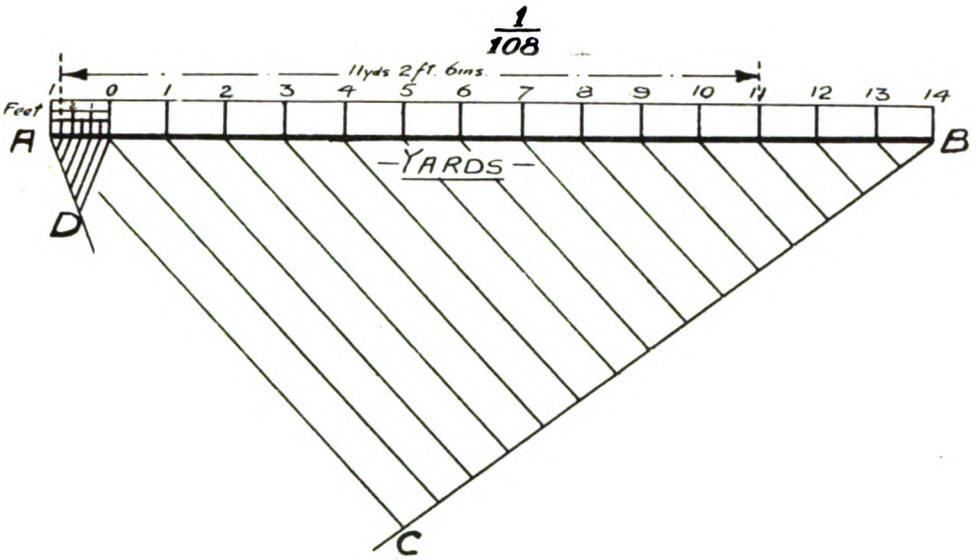

FIG. 91.

GEOMETRY.

Under this heading it is not proposed to carry out anything like a systematic study of geometry, but simply to run over a few constructions and problems which are of general utility.

103. *Scales.*—In Fig 91 we have a method of setting out a scale of 3 yards to the inch. Since 3 yards are equal to 108 inches, this scale is $\frac{1}{108}$, meaning $\frac{1}{108}$th of full size.

In this case a convenient length of 5 inches, representing 15 yards, has been taken for the scale. This length, AB, could have been divided by trial or by measurement into 15 equal parts, each representing 1 yard, but in this case the division has been made by the method explained in Article V. BC was drawn at a convenient angle to AB, fifteen equal divisions of some convenient length were measured off from B along BC, and parallel lines drawn, as shown, to divide AB. In a similar manner AD was used to divide the end fifteenth at A into feet and half feet. These parallels should, of course, be omitted from the final scale.

The zero for the scale is not at A, but is at the other end of the subdivided "yard," as shown. A scale marked in this way is every bit as useful as a scale subdivided all along into feet and half feet. Suppose a distance on a map or plan has been measured off with a pair of dividers, and it remains to find the length represented. Using this scale we must put one point of the dividers on a main scale division, such that the other point will fall either at 0 or amongst the small sub divisions. We will suppose that we have to place one point on the "11 yards" line, when the other point falls at 2 feet 6 inches—as shown by the dotted lines. Then the distance we require is read off directly, without any subtraction, as 11 yards 2 feet 6 inches.

104. In Fig. 92 we have a *Diagonal Scale.*

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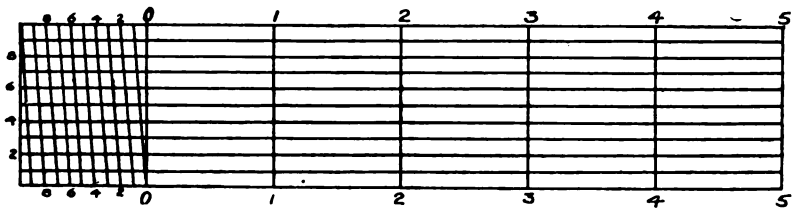

FIG. 92.

This particular scale is 6 inches long and about 1¼ inches wide. It is divided by horizontal lines into 10 "layers" of equal width, and by vertical lines into six equal compartments, each 1 inch long. The left-hand end compartment is divided along its top and bottom edges into tenths of an inch, and straight lines are then ruled across diagonally, as shown.

In Fig. 93 we have the sub-divided compartment shown considerably enlarged, and also the right-hand end, the middle of the scale being omitted. Let us imagine a point travelling upwards from *b* to *d* (along the straight line *bd*). At *b* it will be at a distance $ab = 5{\cdot}10$ inches from the right-hand end of the scale, and when it reaches *d* it will be at a distance $cd = 5{\cdot}20$ inches away, an increase of 0·10 inches. Therefore, since all the ten vertical spaces are equal, we see that as it crosses each space it must increase its distance from the right-hand end by one-tenth of 0·10 inches, or by 0·01 inches. In this way we get lengths on our scale equal to 5·10, 5·11, 5·12 . . . 5·19, 5·20 inches, as shown. This reasoning, of course, applies to any of the diagonal lines, and so we are enabled to scale off lengths correct to $\frac{1}{1000}$ inch.

When scaling off lengths in this way, the even inches will be quite obvious, but the decimal portion will require a little thought. To make this more clear the following points have been marked in Fig. 93

	a',	the decimal for which is		0·35
	b'	,,	,,	0·71
	c'	,,	,,	0·80
	d'	,,	,,	0·02
and	*e'*	,,	,,	0·49

It will be seen that the safest way to read off the decimals is to follow the *diagonal to the bottom* for the first decimal place, and follow the *horizontal to the left* for the second place.

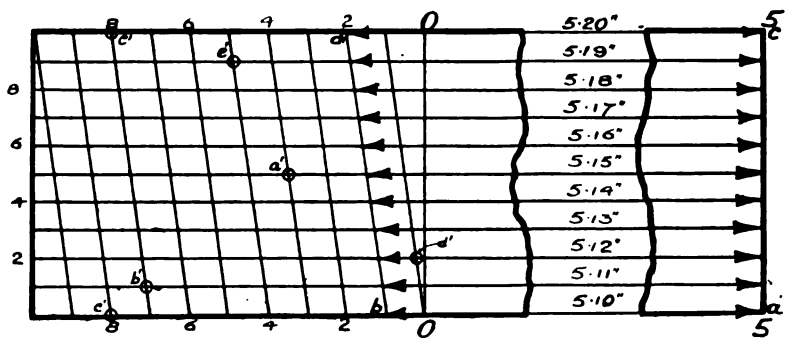

FIG. 93.

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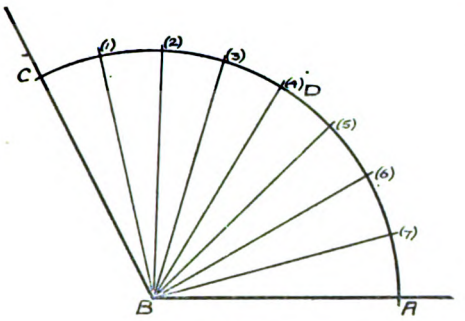


FIG. 94 (A).

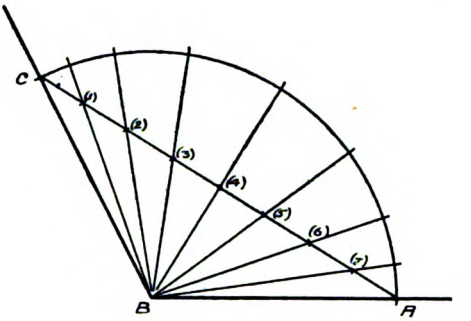
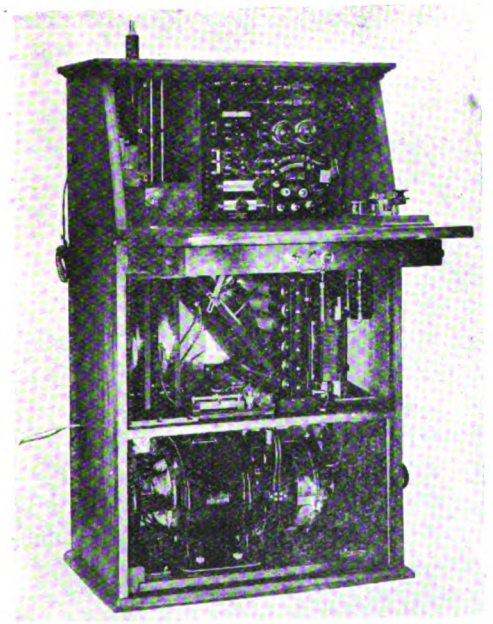


FIG. 94 (B).

105. The *Division of Angles* into a number of equal parts is most readily done by trial, except in a few very simple cases such as bisection or where a protractor can be readily used.

In Fig. 94 (*a*) the angle *ABC* is divided into 8 equal parts. The arc *CDA*, of some convenient radius is drawn with centre *B*, and divided into 8 equal parts, by trial, at the points (1), (2), (3) . . . By joining *B* to each point of division the angle is divided as required. It should be noticed that dividing the straight line *AC* into 8 equal parts, and using these points of division gives a very unequal division of the angle—see Fig. 94 (*b*).



Marconi ¼ k.w. Set with Receiver.

In our September issue we gave an account of the new Marconi ¼ kw. Transmitter which has been prepared to supply the need for moderate power installations on board ship. We are now able to publish a photograph of a further ¼ kw. cabinet set into which a receiver has been built, so as to make the whole apparatus self-contained. As will be seen from the illustration the transmitting portion is identical with that already described, and occupies the lower portion of the cabinet. The door of the upper section is so hinged that when brought forward it forms a table, the transmitting key being placed on the right-hand side. On the panel at the back of the cabinet will be seen the controlling switches, starter, fuses, etc., on the right, and the crystal receiver with its potentiometers in the centre. On the left-hand side is placed the receiving inductance.

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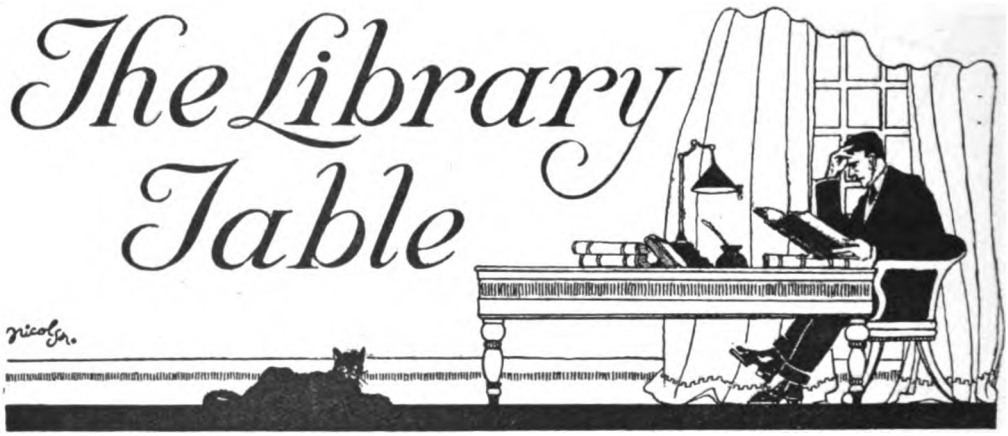

"SUN, SAND AND SIN." By Joan Kennedy. London: Hodder & Stoughton. 1s. net.

With South-West Africa so far distant, and with the European conflict practically at our doors, it is not strange that the wonderful march of General Botha into what was known as German South-West Africa has not received the attention it deserves. To the stay-at-home reader the brief reports from the great Boer General conveyed little, indicating as they did merely a progress of so many miles. Only occasionally did we have a glimpse of some of the difficulties and horrors of that great march through blinding sand and burning sun; a laconic despatch would mention the poisoning of wells and defiling of the few oases which the barren land afforded. Miss Joan Kennedy, in the book before us, sets out to tell in a series of graphic stories some of the wonders of this famous expedition. "This is not a history," says Miss Kennedy in a foreword. "The history of the campaign in South-West "Africa has yet to be written. It will make good reading—that tale of how 322,348 "square miles of territory came to be added to the red patches on the map of the "world. . . . Rightly did Botha call it the land of sun, sand and sin."

Some good stories are enclosed within these covers, and some, such as that which describes how a trooper who dropped out exhausted in the desert march and managed to keep himself alive are gruesome in their vivid detail. Of wireless stories, too, here are a few, including one which has already appeared in the columns of "Wireless Telegraphy in the War" in our magazine.

Miss Kennedy has a fine sense of the dramatic in telling her tales, and the book will certainly help to bring home to many who had not given the matter much thought how much we owe to the great South African General and the faithful, hardy and heroic force which accompanied him across the great deserts of gleaming sand to a victory perfect and complete.

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"GAS, OIL AND PETROL ENGINES." By A. Garrard. London: Whittaker & Company.

The importance of the internal combustion engine in our daily life can be realised when we consider that upon it depends the running of practically every motor-car,

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aeroplane, airship and motor-boat. Further, an interesting number of motor-ships are traversing the great ocean highways, and this form of engine has also invaded the railways, for the running of local trains and of small branch lines. The wireless operator, too, is not unacquainted with it, for a number of emergency dynamos driven by internal combustion engines are in use on board ship. The book under review is devoted to the explanation of various forms of gas, oil and petrol engine, and with the aid of a number of excellent diagrams makes the whole subject quite clear. Commencing with a chapter on history and development, we are next treated to a description of general principles followed by explanations regarding the fuel and combustion. Gas engines, large and small and of various types, are then explained, petrol engines coming next in treatment. The comparatively recent invention of the Diesel engine, making possible large power units with comparatively crude fuel, was the first device to bring the motor-ship within the realm of economical running, and in the chapter devoted to this type of power plant much interesting matter will be found. The older type of oil engine comes next in the book, and producer gas plant is not forgotten. In chapter 10 the recently invented " explosion pump " of Mr. H. A. Humphrey is clearly explained. This pump is of very high efficiency, and a great many of the usual parts of the internal combustion engine and pump are dispensed with. Lastly, the important subject of ignition is treated in a separate chapter, both the elementary principles upon which such device is worked and their practical application being thoroughly dealt with. Altogether this is an excellent book, which should be in the hands of all who desire to make themselves acquainted with any of the forms of engine to which we have referred.

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" DYNAMOS AND MOTOR ATTENDANTS AND THEIR MACHINES. By Frank Broadbent, M.I.E.E. (Eighth Edition). London : S. Rentall & Company, Limited. 2s. 6d. net.

The success of this well-known book can be judged from the fact that this is the eighth edition, and the author has taken the opportunity of thoroughly revising the book and bringing the matter right up to date. It can be recommended to all who desire to have a good sound and general knowledge of dynamos and motors, and our experience has shown us that there are a very large number of people to whom the perusal of the volume would be of great help. For instance, at sea on small cargo vessels where an electrician is not carried, it is the exception rather than the rule to find that the chief engineer understands electrical matters. For some reason or other few engineers on such vessels run the dynamo at the proper voltage, and as a consequence the lights are sometimes brilliant, sometimes dull, and generally unsatisfactory. Excellent dynamos are in many cases ruined by mismanagement, and sparking brushes left to burn unhindered, ruining the commutator in the process. This little book not only explains the principles upon which the dynamos and motors work, but also deals with such matters as faults and how they may be remedied, how to choose a dynamo or motor, accumulators and all matters which a dynamo and motor attendant should understand. We notice in the chapter on accumulators that the Edison battery is clearly illustrated and explained, whilst a number of

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practical points on battery maintenance are given. The price of the book is reasonable, and it should be within the reach of all.

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"A TREATISE ON THE THEORY OF ALTERNATING CURRENTS." By Alexander Russel, M.A., D.Sc., M.I.E.E. Volume 2 (Second Edition). Cambridge: The University Press. 15s. net.

This excellent treatise, the first volume of which was reviewed in our January, 1916, issue, is designed, in the words of the author, "to give a sketch of the theory of "the working of alternating apparatus, in the hope that it will prove helpful to "engineers, teachers and advanced students." In the 550 odd pages which go to make up the volume the reader will find the subject very fully treated, mathematical explanations being given on practically every page. Whilst not a book for the elementary student, it will yet appeal to the ever-growing circle of readers who are not content with skimming the surface of alternating current theory, and these will appreciate the numerous clearly drawn diagrams which are interspersed throughout the book.

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"A MANUAL OF PRACTICAL PHYSICS." By H. E. Hadley, B.Sc. London: Macmillan & Co., Ltd. 3s.

This book is designed to fulfil the need for a manual of elementary practical physics of reasonable size and moderate price, suitable for students working to the standard of the intermediate examinations of various British Universities. The matter is presented in a clear and interesting manner and could profitably be studied by all senior students in secondary schools who propose to specialise in science.

A sound knowledge of physics is not without value to the wireless student and operator, particularly to those who desire to understand more fully the principles upon which many parts of the apparatus are based. In fact, one may go so far as to say that no student of applied electricity can hope to make much progress until he has first obtained a good grounding in physics.

We are glad to see that the numerous experiments described and illustrated throughout the book are of such a nature that they can be easily carried out without the aid of expensive apparatus. Altogether this is an excellent little book and can be thoroughly recommended.

* * * * * *

"DREAMS: WHAT THEY ARE AND WHAT THEY MEAN." By a Member of the Norbury Literary Society. Price 1s. 1d., post free. From J. W. Wickwar, 81 Kilmartin Avenue, Norbury, London, S.W.

Dreams and dreaming are as old as the hills, and have always supposed to have had some mysterious significance about them. The enquiring mind asks "What can they mean?" and an attempt has been made in this little work to elucidate the problem. Almost every kind of dream ranging from the "day-dream" to the "night-mare" is dealt with, and under "prophetic dreams" we have a complete account of that wonderful dream known as Mother Shipton's, in which every vision has come to pass, except the last one, which was—the end of the world.

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Personal Notes

FROM Australia comes the news of the death of the Rev. Father Archibald John Shaw, of the Sacred Heart Order of Missioners. As a young man he was employed for some time in the General Post Office at Sydney as a telegraph operator, and after entering the Sacred Heart Monastery he still retained his interest in matters telegraphic. Experimenting in wireless telegraphy, he produced what was known as the "Shaw Wireless System," and with the support of a syndicate entered into the business of motor and dynamo manufacture as well as wireless telegraphy.

* * * * * *

THE LATE
PRIVATE R. W. R. FLETCHER.

In connection with the paragraph which appeared in our October issue, regarding the sad death of Private R. W. R. Fletcher, we are now able to reproduce a photograph, although no further particulars have come to light regarding the manner in which he met his death. Private Fletcher was very popular with his fellow workers in the Wireless Press, and his loss will be severely felt by his old comrades.

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With reference to Lieut. Bernard C. de B. White, who was killed in action on July 1st of this year, Major W. A. Farquhar, of the Royal Scots Fusiliers, says :

"Mr. White took part in the general offensive July, and died a soldier's "death in France, where he was buried decently, and, although I have not "heard it, I have every reason to believe that a cross has been erected over his "grave to mark the spot. I hope it may be some consolation to his friends and "people that he gave his life nobly for his King and Country, and no one can do "more.

"The battalion, and everybody connected with it, behaved magnificently "under the most trying circumstances."

* * * * * *

We regret to announce that Petty Officer William Herbert Hodgson, of Scarlet Heights, Queensbury, near Halifax, who was well known to many of our readers as an operator in the service of the Marconi Company prior to the war, fell with a seaplane into the sea on October 12th and lost his life. Petty Officer Hodgson was an air mechanic and observer, in which capacity he has

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THE LATE LIEUT. A. C. STYLES.

served for some time, having joined the Air Service about two years ago.

On behalf of his many friends in the Marconi Company, we offer our sincerest sympathies to the late Mr. Hodgson's parents and five sisters in their terrible bereavement.

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We also regret to announce the death, in action, of Lieut. Alfred Cornwall Styles, of the Cheshire Regiment, on July 18th last. Lieut. Styles was but 26 years of age, and was married as recently as December last.

Educated at Dulwich College, Lieut. Styles became a Marconi Engineer, and went abroad for the company to fill various appointments. He had previously been a Territorial, and on returning home at the outbreak of war was granted a commission in the Cheshires, and went to the front about nine or ten months ago. Letters received show that his battalion had been in very heavy fighting for some days. During a lull, and whilst some rest was being snatched in the trenches, a shrapnel burst and killed him while he was asleep. His Colonel writes, saying he was a very efficient officer, and we take this opportunity of expressing our deep sympathy with his bereaved widow in her sad loss.

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Congratulations to Warrant Telegraphist Herbert Thomas Little, of Eltham, on his marriage to Miss Laura Gladya Dye. The bridegroom, who is well known in Ramsgate, was a wireless operator in the service of the Marconi Company prior to the war, and we are sure his old comrades will join with us in offering the heartiest congratulations to the happy pair.

* * * * * *

Mr. Henry W. Allen, Secretary and Deputy Manager of Marconi's Wireless Telegraph Company, Limited, and the Director and Manager of the Wireless Press, Limited, was re-elected a member of the Council of the Chartered Institute of Secretaries at the General Meeting, held on November 9th.

WARNT. TELEGRAPHIST H. T. LITTLE.

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Pastimes for Operators

Sketching

By "REDAX."

SITTING down to write on the subject of sketching as a hobby for wireless operators, I am faced with the fact that the majority of my readers will glance at the heading and say, " Ah, yes ! Sketching is all right for some, but it's not the " hobby for me. *I* can't draw. Artists are born, not made ! "

To all of these I would say : " Read this article through to the end, for it is " quite possible that you will find that you have abilities in this direction which " you had not previously thought of." I am convinced that a very great number of people cannot sketch because they have never seriously tried.

The advantages of being able to sketch are so numerous and to such a degree obvious that it may almost be considered a waste of time to enumerate them. Wireless operators as a body enjoy exceptional facilities for travel—facilities far greater than those of the average Mercantile Marine officer, who is usually tied to one ship for many voyages, and perhaps for years. Seeing many lands, the operator will naturally wish to keep some record of these ever-changing scenes, and if he is a camera enthusiast he may turn to photography to help him, but there are many to whom photography makes no appeal, who count it " messy," and, not an unimportant fact, expensive ! But if he is able to sketch he may bring home a note-book full of interesting drawings and impressions, which will serve to remind him throughout the rest of his life of the foreign lands and scenes he has visited. On the score of expense there is little to be said, for a pencil and paper are always available and cost practically nothing.

Many operators have gained quite considerable fame by their little humorous sketches and caricatures. There is a great deal of fun to be obtained in this way, provided the boundaries of good taste are not overstepped. It is true that this type of sketching can rarely be taught—it comes as a natural gift ; but it can be developed to a great degree in those who possess the rudiments of humorous expression.

Lastly, there is a form of drawing greatly neglected by most operators, and capable of being readily acquired by practically all, and that is the making of diagrammatic sketches of apparatus. Many a time we have known an operator to be asked some question on his apparatus, and, owing to his inability to draw a clear and lucid diagram, he has floundered on for an hour or more in an endeavour to give the information required. Even to those who possess no artistic gifts, and to whom the beauties of such expression mean nothing, the ability to draw diagrams can be easily acquired.

On this point the reader may say, " Yes, I agree with all you have written, but " how am I to find out whether I have this latent ability you speak of, and how " can I improve the almost negligible ability I already have ? " In an endeavour

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to answer this we must consider first of all what lies underneath the power of expression.

To be able to draw we must be able to *observe* clearly ; we must be able to form a clear perception in our minds of that which lies before us. Have you ever noticed how some men have travelled between, let us say, London and New York for years on end and yet seem unable to describe anything of importance in either of these ports ? The reason is not that they have not *seen* the places on which they are questioned, but that they have never given any thought to the sights which come before their eyes. In a phrase they lack the power of observation. If you want any proof that most people see a great deal but observe very little, just ask the next friend you meet if he can describe the pattern of the wallpaper in his bedroom, if the point of the well-known red triangle in the Y.M.C.A. sign is at the top or bottom, and a few other questions of a like nature. You might, at the same time, ask him whether the hour of six on his watch is shown in Arabic or Roman numerals. He will probably say at once in Roman numerals, but when he looks he will find that the dial of the second hand completely covers the space where the six should be, so that there is no figure at all.

Having realised the difference between seeing and observing, the reader should practise observation at every possible opportunity. If when reading this he happens to be on board ship, I would suggest that he sit down with a sheet of paper in front of him and a pencil, and endeavour to make a simple drawing of the ship on which he is serving. After drawing a straight line for the deck he will probably find that he has no clear idea of the exact position of the masts, their height in proportion to the length of the deck and the methods by which they are stayed. A few minutes on deck should give him the necessary information, and enable him to proceed with his little sketch. By careful observation of every feature and by taking notice of such points as the diameter of the funnel in proportion to its height, position of capstans, well-decks, hatchways, and the like, he will soon find himself with a very presentable outline of his ship.

By this time he will have noticed many points regarding the vessel which he had not previously remarked, and will seek to compare his present ship with others upon which he has served. Once his interest has been aroused he will notice many points of difference upon passing vessels which have previously escaped his observation, and in a short time should be able to make a sufficiently accurate sketch for others to be able to identify the vessel from his drawing. Ability to do this may prove of great value.

The art of sketching rapidly depends not only upon the skill and training of the artist's hands, but also upon the power of perceiving at a glance the essentials of the object in view, and the operator should ask himself when on deck watching passing ships, " What features on that steamer differentiate it from the vessel " on which I stand ? " This is a particularly interesting exercise when comparing ships of the same line where the colour of the hull and funnels is the same in each case. How many North Atlantic operators, I wonder, knew of the differences between the *Lusitania* and the *Mauretania*—differences which were sufficiently marked to enable the observer to see which ship was which, even on the distant horizon ?

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One of the dissimilarities was in the deck ventilators, which were of the mushroom type on one vessel and the ordinary type on the other.

Space will not permit me to deal at all fully with the methods of practising sketching, but I think sufficient has been said to give the keen operator a start on the right road. There are a number of small handbooks on drawing to be had from which one can learn the elements of perspective, and to all who are sufficiently keen to take up the study seriously there are always the correspondence courses in drawing, which are quite good and widely advertised. In these courses the student is required to make sketches and drawings of certain objects, which are criticised by the skilled instructors at the correspondence school. By having his errors pointed out to him and by receiving a few words of encouragement here and there, when it is found he is proceeding on the right lines, the student will soon be able to overcome the initial difficulties, and may possibly achieve considerable success in one or other of the branches of sketching. It may not be without interest to mention here that Captain Bairnsfather, whose humorous sketches from the front have attained such popularity, has admitted that he owes much to one of the correspondence courses in drawing.

As an example of what some operators are doing in the way of sketching, we would refer readers to page 294 of the July issue, on which appears the reproduction of a water-colour painting of H.M.H.S. *Aquitania*, by Mr. P. Aris, who is well known among his friends for his excellent sketches and water-colour painting on maritime subjects. In our June number on page 202 there appeared a pen-and-ink drawing of the Quebec Station by Mr. Douglas R. P. Coats of the Canadian Marconi Co., and the small black-and-white illustration at the foot of page 203 is also by the same artist. In February of this year we published a highly interesting description on page 742 of "The Wireless Equipment on German Submarines." Mr. Percival Denison, the operator on the torpedoed *Den of Crombie*, had the presence of mind to make a couple of rough sketches, one of the s.s. *Den of Crombie* sinking, with the German submarine alongside, and the other of the peculiar aerial equipment carried on the enemy craft. These sketches, although very rough, contained all the essential features, and our artist, Mr. W. A. Cross, was able to work up from them the excellent illustrations which appear in the article in question.

Altogether I think I have said enough to show that sketching as a hobby is well worth "working up," and, even when no great success is attained, the additional facility in observation which is developed in the practice is bound to be of great value in one's other pursuits.

Share Market Report

LONDON, *November 13th*, 1916.

THE share market has been very quiet during the past month, and there is little change to report. Prices, as we go to press, are: Marconi Ordinary, £2 16s. 3d.; Marconi Preference, £2 6s. 3d.; Marconi International Marine, £2 2s. 6d.; American Marconi, 16s. 6d.; Canadian Marconi, 9s.; Spanish and General Wireless Trust, 9s.

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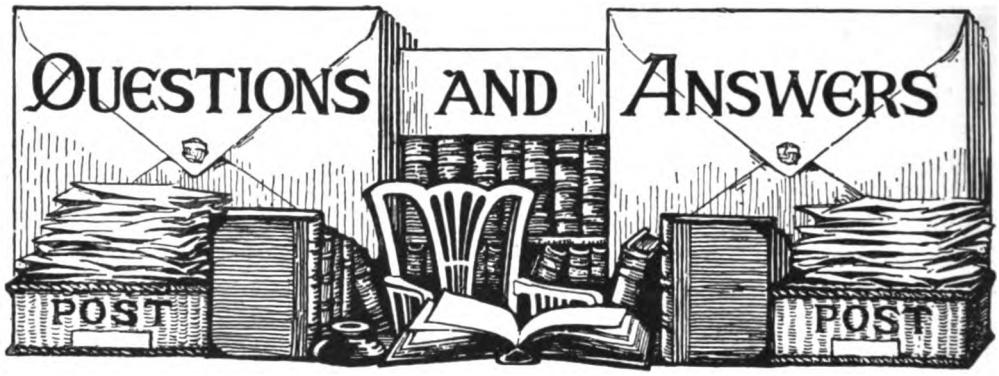

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

J. R. (Middlesbrough).—We regret we cannot answer questions regarding the cable service and their stations, as matters such as these are outside our province. With regard to your question whether it is possible for young lady post office assistants with good telegraphic capabilities to obtain permanent situations in either wireless or cable offices, and if so whether it is not possible providing their telegraphic qualifications are satisfactory to obtain employment in either the wireless or cable offices without the necessity of first entering a school for tuition, we can only speak with regard to the wireless service. A certain number of skilled lady telegraphists have been engaged by Marconi's Wireless Telegraph Company, Limited, for service at some of their wireless stations, and these have been given permanent appointments. They have, however, in all cases been given wireless training in the Company's own school before taking up their duties. In reply to your last question we would refer you to the wireless map of the world published in the *Year Book of Wireless Telegraphy and Telephony* for 1916.

"UNDULATOR" (R.F.C.)—Wireless engineers are mostly recruited from fully trained electrical engineers who have been through a full course at a recognised technical college. For a list of these approved institutions you should apply to the Chief Engineer, Marconi's Wireless Telegraph Company, Ltd., Marconi House, Strand, W.C., who will also forward you conditions of appointment for wireless engineers if you ask for it. You are apparently studying the right subjects, and if you obtain the particulars above referred to, you will see just what a wireless engineer is required to know. Thank you for your good wishes.

A. W. (London, S.W.)—We are glad you were interested in the article on the Goldschmidt Transatlantic Station in the October issue. In the Digest of Wireless Literature we give further particulars of the Goldschmidt Alternator. The wireless station near Brussels which was blown up to prevent it falling into the hands of the Germans was a private installation. The following particulars regarding it appeared in the *Cambridge Magazine* for November 21st, 1914: The station was erected at Laeken near Brussels, on a plot of ground given by King Albert. The station was erected by a Mr. Robert Goldsmith (*not* the Professor Goldschmidt of High Frequency Alternator fame. ED.). Current was supplied by a high frequency alternator driven by a 400 H.P. motor. The aerial consisted of eleven wires supported by eight steel masts, two of these being 135 metres high and the remainder 90 metres high. The maximum wavelength was 8,000 metres. On Wednesday, August 19th, 1914, the station was blown up by the Belgians. The amount of damage done was estimated at about £200,000.

W. G. C. (Papua).—Your informant is quite correct. It is the standard practice to measure the output of the station on the long dash. Many thanks for your very interesting letter. We are glad to hear that our magazine gives so much pleasure in such a far distant part of the world.

L. C. A. (Norwich).—The Marconi Company can only accept for its operating staff men who are physically fit, and the fact that you have a slightly paralysed right leg would, we are afraid, debar you from being accepted for that Company's service.

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G. L. P. (London).—We cannot pass an opinion upon which is the best course for you to take, unless you inform us which profession you are likely to take up. If you intend to enter upon the career of a wireless telegraphist we do not think you will gain much solid advantage by taking a combined cable and wireless course. If, on the other hand, you think of entering the cable service, you might with advantage take the combined course as a number of Cable Companies have repair ships fitted with wireless telegraphy, and a knowledge of wireless would probably be useful to you. If you care to write to us again stating more fully your intentions with regard to a career, we may be able to give you further assistance.

N. S. W. (Wallington).—We cannot say which is the *best* book on dynamos, motors and alternators, or which is the best book regarding installations and design of apparatus used on aircraft. Everything depends upon the extent of your present knowledge. If you have no knowledge of elementary electricity and magnetism it is useless buying such a specialised book as one dealing with dynamos and motors alone. Again with regard to alternators, if you have a good knowledge of alternating current, we can advise you of a book devoted exclusively to alternators and their work. There is no book devoted exclusively to the design of wireless apparatus used on aircraft, nor is there likely to be one published before the end of the war as great advances have been made in this direction by naval and military experts and commercial firms engaged on apparatus used in the war. All this is of course secret for the present. We would take this opportunity of asking our readers to make their queries as full as possible, as we are often severely handicapped by not knowing exactly what our correspondents require to know and the extent of their present knowledge. This will be evident from one or two replies given above.

H. W. (Rotherhithe).—As it is evident from your letter that you have only an elementary knowledge of wireless telegraphy we would suggest that you obtain *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay, and *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, which are advertised in this issue. By studying these books you will get all the knowledge you require and gain considerably more information than we could give you here, as it would be impossible for us to answer your questions with the limit of space we have at our disposal.

C. A. (Birmingham).—Yes, we should think that the Royal Naval Air Service could make excellent use of your knowledge of motors, and we would suggest that you apply to the nearest recruiting office for any further particulars you require.

AMBITIOUS (Barrow-in-Furness).—For particulars regarding the conditions of employment and prospects of a Marconi operator, we would suggest that you apply to the Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C. In answer to your second question we cannot of course pass an opinion as to which is the best wireless school, but if you apply to some of the institutions advertising in our pages and ask them to send you particulars, you should be able to make the choice yourself. In answer to question 3 it is necessary for a wireless operator to have a good general education.

G. L. (Hunstanton).—The rotary spark gap and the quenched gap are both highly efficient, but whether one is more efficient than the other depends upon the general design of the circuits connected thereto. In answer to your second question you have apparently mistaken the purpose of a potentiometer. A potentiometer and battery used in connection with a crystal detector does not amplify the receive signals, but merely enables the detector to be brought into the most sensitive condition by giving the required potential difference across the point of contact. Some crystals do not require the use of this piece of apparatus. Question 3. We cannot answer any questions of this nature nor reproduce any diagrams of circuits such as those you show while the present restrictions are in force.

A. B. G. (Glasgow).—You do not say whether you hold a P.M.G. certificate or not, nor do you say whether you are conversant with the construction and manipulation of Wireless Apparatus. If the answer to any of these queries be in the affirmative you can enter the Royal Naval Air Service (applying to the R.N.A.S., Central Training Establishment, Lincolnshire) or the Royal Engineers or the R.F.C. If you wish to join the Royal Engineers, you should communicate with the Commanding Officer, Wireless Training Centre, Worcester. If you desire to join the R.F.C., communicate with the Recruiting Officer, R.F.C., The Polytechnic, Regent Street, London, W. In either case you would enlist for the period of the war only.

L. W. B. (Dover).—Your question is really answered in the "Note of the Month" dealing with this matter, which appears in our present issue. For admission into the R.F.C. you would have to apply to the Recruiting Officer, R.F.C., The Polytechnic, Regent Street, London, W. But in any case we understand it will be necessary for you to obtain leave from your Commanding Officer before applying for a transfer.

SIGNALMAN (Granton).—Applications for entry into the R.F.C. should be made to the Recruiting Officer, Polytechnic, Regent Street, London, W. You should obtain leave from

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your Commanding Officer before applying for a transfer.

A. H. F. (Bishops Waltham).—With reference to your first question asking how to determine the correct condenser capacity for a given inductance coil, do you mean the condenser in the base of the coil or the condenser in the oscillating circuit, which the coil is used to charge? Question 2. To test the condenser in the base of the coil to see whether the dielectric has broken down, a galvanometer is connected across the condenser terminals. If the dielectric is unpunctured there will be no reading of the galvanometer, but if the insulation is broken down there will of course be a reading.

F. P. (Banbridge).—Your first question we cannot answer while the present restrictions are in force. In reply to your second question everything depends upon the particular station, the disposition of the earth plates and the position of the building with regard to aerial and earth. In some cases it might improve the earth to have it connected with the galvanised iron of the building, and in any case no harm would result from the fact that the earth lead were not insulated from the side of the shed. We much regret that owing to pressure of work and the fact that we have a great number of questions and answers to attend to, we are unable to answer your queries by post.

AJAX (Abercynon).—We regret that we cannot pass opinions as to the relative merits of the various wireless training institutions, but we may say that the school you mention is a genuine training institution and the correspondence classes conducted by it are, we believe, quite good.

A. A. (Malta).—We would suggest that you obtain a copy of one of the English electrical papers, such as the *Electrician* or the *Electrical Review*, in which you will find advertisements of the leading electrical firms. If you write to some of these they may be able to help you. If you apply to the Chief Engineer, Marconi's Wireless Telegraph Company, Limited, Marconi House, Strand, London, W.C., for conditions of employment for Wireless Engineers, this will also help you.

RADIOGONIOMETER (Liverpool).—The articles to which you refer will not be reprinted in book form, so far as we know at present. (2) We do not know of any book on advanced wireless similar in style to the publication you mention. If you will let us know more exactly the type of book you require, we will endeavour to advise you further. (3) The information in your third question is insufficient for us to answer your query. Are you referring to the Marconi-Bellini-Tosi Direction Finder or to some other form of direction finding aerial?

W. C. S. (H.M.T. ——).—The station with call-letters "W.S.T." is the land station at Miami, Florida, as given in the 1916 edition of the *Year Book*. We cannot account for the phenomenon you mention, and in any case do not think it is due to the cause you suggest. (2) The type of atmospheric you refer to is well known to the writer. It frequently precedes a squall of sleet, and is referred to in this connection in the article on "Some Problems of Interference" (1916 edition of *Year Book of Wireless Telegraphy and Telephony*).

W. H. L. (Timaru).—The book we are publishing shortly, entitled *The Measurement of Capacity and Inductance*, by W. H. Nottage, B.Sc., will deal fully with the points raised in your letter, and we would strongly advise you to obtain it. Your second query cannot be answered, as you do not say how far apart the two aerials are placed.

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How to Learn the Morse Code

The Telephone Receiver

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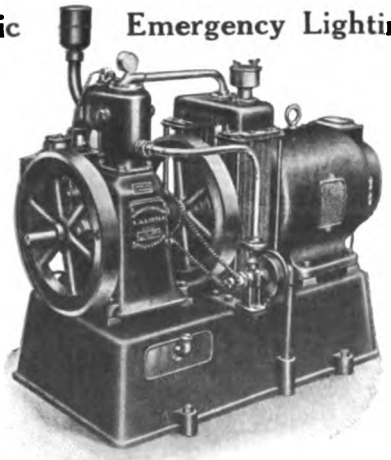

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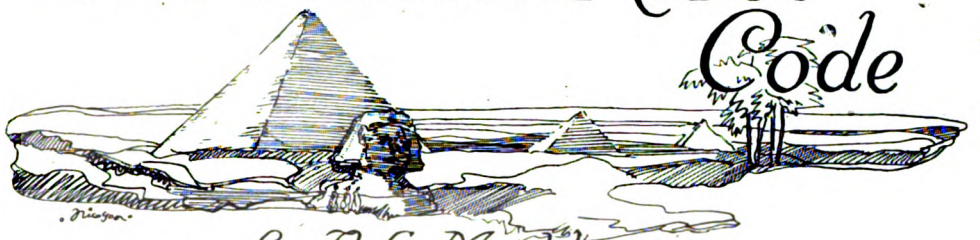
The Human Morse Code



by R. G. Micklam

THE present article is an attempt to put before the reader a simplified system of committing the Morse Code to memory, by the use of a succession of what may be termed mnemonic groups.

We take a mental passage to Egypt, therefore, and seat ourselves directly in front of the Pyramid of Cheops. We note, as we do so, a group of Arabs standing by, who had evidently received a radiogram from England apprising them of our advent, for no sooner are we comfortably ensconced than they race away and begin scrambling up the face of this 6,000-year-old monument. Having reached their appointed places, they squat down simultaneously, clasping their arms round their shins and sinking their chins on to their knees, so that they appear to us, some 500 feet away, like a collection of glorified full-stops, their blue galabiehs forming a pleasing contrast against the light brown ridges of the Pyramid. We notice, too, that they have arranged themselves in a symmetrical group, as Fig. 1, and we turn to a Dragoman standing by to ask what this figure may mean. He tells us the Arabs take us for mere tourists (Pshaw!) and want to earn "backsheesh." Well, nobody begrudges an honest man a mouthful of bread: on the other hand, by quite a happy coincidence the Arabic word for bread is "EISH" and these cunning fellows have so grouped themselves as to portray in Morse Code the four letters composing that word, since one dot (·) represents the letter E, two dots (··) represent I, three dots (···) S and four dots (····) H, and if this is how we are to learn the Morse alphabet, it promises to be quite a simple matter.

The second evolution appears to be the preliminary to a precipitate roll down the oblique face of the Pyramid, as the six men composing the three upper groups suddenly straighten themselves out, as in Fig. 2, and we are on the point of wireless-ing to beg them not on any account to break their Egyptian necks for the mere gratification of our unworthy selves, when we are given to understand they threaten nothing more violent or deadly than the representation of three further code letters, the topmost man now describing himself to a T (—), the second two making out that they represent M (— —), while the third three aver it is *they* and not *we* who should be surprised, since they collectively represent O! (— — —). On learning this, however, we begin to feel just a trifle uneasy in our minds, for it can hardly have been a second coincidence that, by a combination of the two groupings, it should have spelt out the word "EISHTMO," which is the Arabic

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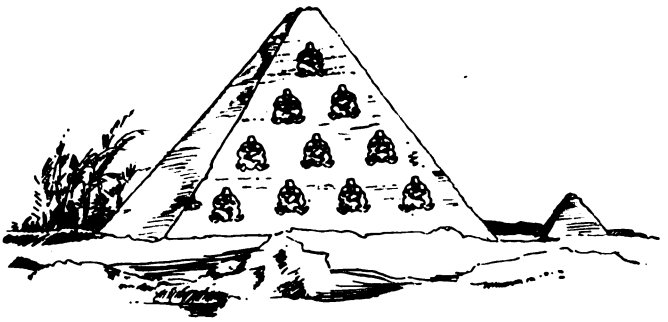

FIG. 1.

equivalent for "Insult him." If these saucy sons of Ham are laughing up their sleeves at us, they will not get their mouthful of "eish" after all. . . . And yet what recks it? We are out for intellectual recreation and have the satisfaction of memorising in these two groups no less than seven letters of the Morse alphabet.

The Arabs now call upon several more of their sun-scorched brethren to join them, and, thus reinforced, proceed to entertain us with a third grouping, a picturesque one withal, for we here get a combined figure of squatting and lying (latter adjective refers to position, not to characteristic) Egyptians, and this is how they appear to us as Fig. 3, which is certainly not a complicated figure, yet it helps us to tuck away in the recesses of our brain-boxes six more letters, viz. :—

(A) ·—	(U) ··—	(V) ···—
(N) —·	(D) —··	(B) —···

Happily these form no equivocal word in Arabic (nor, forsooth, in any other civilised language), so we conclude we have been entertaining unworthy suspicions of our desert friends. While we are mentally registering the six symbols, however, the top two sets of men begin quarrelling and approach each other in a menacing attitude, but as we are at the safe distance of 500 feet from the seat of disturbance, we content ourselves with merely adding another letter to the tablets of our memories, for the conjunction of the two opposing factions represents the letter P (·——·). Meanwhile the two couples commence stealthily to manœuvre round one another, so that, although they began thus ·——· they presently stand thus —··—. It is all quite fortuitous, of course, still we manage to profit by the chance grouping, since —··— is X and gives us an Xtra letter—though this is no Xcuse for perpetrating an Xecrable joke.

Do we realise that we are already considerably more than half way through the alphabet?

Not without casualties, however, for in the fracas above alluded to three men are injured: the first is therefore gently laid down, a dark-visaged brother sits at his head, fanning him with the tail end of his robe, while another

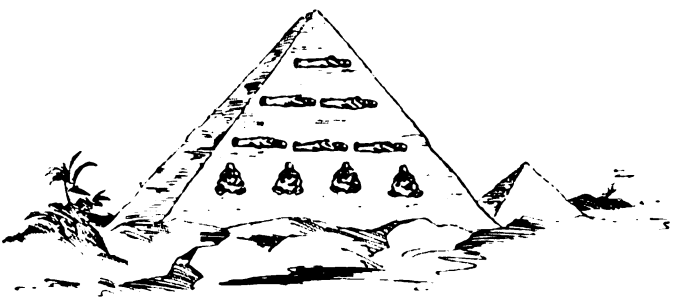

FIG. 2.

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sits at the injured man's feet and tickles his toes with a spike of camel grass, and we simply cannot resist the temptation of placing another letter in our mental warehouse—viz., R, for the three men are now grouped thus · — ·. The two other wounded fellows call out faintly for "water" (they dare not make it "whisky and soda," being strict Mohammedans), so they are likewise tenderly laid out, head to head, and one of the onlookers sits between them, giving each alternately a sip of water out of his inverted tarboosh, hastily filled from the pump of Mena House Hotel close by; thus the group becomes — · —, and as it must be a hopelessly diseased wind that cannot manage to blow somebody some good somehow, we so far take advantage of the woes of these two unhappy wretches as to add the letter K to our rapidly growing Morse alphabet, thereby accounting for 17 out of the 26 letters.

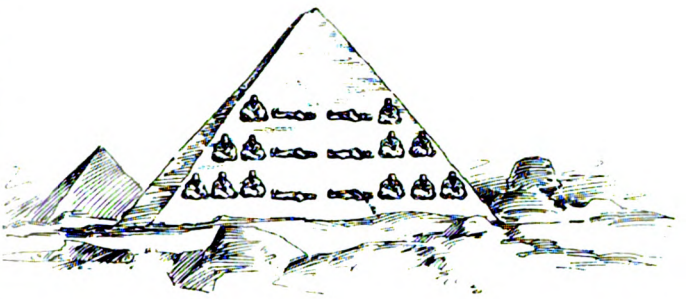

FIG. 3.

Another group composed of six men evolves itself as in Fig. 4, but the component parts thereof immediately begin a 120° in the shade argument. As far as our obliging Dragoman is able to make out from this distance and the echoes thrown back from the face of the Pyramid, they are talking about cricket and the left-hand three cannot convince the right-hand trio that "W. G." was the greatest cricketer the world has ever seen. We, having no doubts about the fact, take the chance of identifying the late champion with his Morse initials, though he wouldn't have thought we knew much about cricket if we had only allowed him four stumps and two balls for a county match, · — — — — ·.

The pantomime is here rudely interrupted by the sound of a buzzing airship propeller, and, looking up, we descry a beautiful monoplane gracefully winging its way across the cerulean vault, heading straight for the summit of our Pyramid, behind which it presently disappears. We recollect this is the French aviator, *De Vol Plané*, attempting to win the £5,000 prize by making the circuit of the world, upside down, without descending once for petrol, but in the midst of our speculations as to his chances of success we are recalled to the business in hand by a sudden shuffle on the part of our acrobatic friends. They have

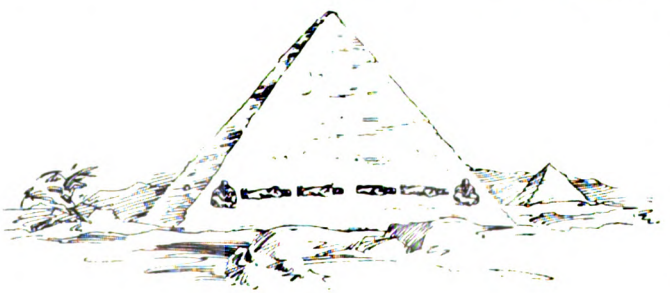

FIG. 4.

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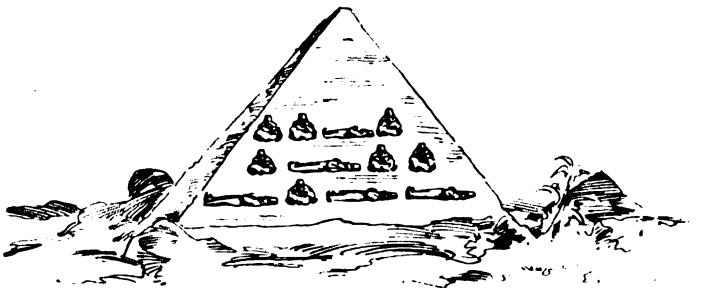

FIG. 5.

forgotten their cricket controversy and hastily thrown themselves into a curious group, as Fig. 5, which seems, to us, just a horrid jumble of people, until Mr. Know-all, our Dragoman, explains that the group represents the three letters F L Y, which is appropriate enough in the circumstances, as we feel bound to admit ; and get mentally busy again.

Our dusky entertainers now complete the alphabet (what, *already ?*) with a quadruple group, for which, to our chagrin, we are able to find no mnemonic peg whatever (Fig. 6), but which we are told represents the four letters C J Q Z, and I defy any man to make anything approaching an intelligible word out of that.

I conclude this article by drawing attention to a very curious fact in connection with the Morse Code—viz., that in distributing his symbols over the alphabet, Mr. Samuel Finley Breeze Morse (to give him his full name) did not, in many cases, allocate the *shortest symbols* to the *most frequently used letters*, the amount of divergence from the ideal distribution being shown in the subjoined diagram.

Counting the dot as 1 and the dash as 2, we get a specific time-value for each Morse signal, and it will be seen that column four of the diagram represents the correct progressive order of the ideal Morse alphabet, beginning with a single dot valued at 1 and ending with a symbol composed of a dot and three dashes valued at 7. Thus, the letter E, which is by far the most frequently used letter in the alphabet, is rightly given the shortest Morse signal : T being the next letter in order of frequency is awarded the next shortest signal, and so on, until we find Z, the least employed letter, deservedly saddled for its laziness with one of the longest Morse signals.

But by Mr. Morse's allocation, as will be seen on reference to column five of the diagram, only 14 out of the 26 letters are correctly suited, with corresponding loss of time in transmission, and it may be observed in this connection that the Morse Code is in use on no less than 95 per cent. of the telegraph lines of the world.

It seems almost a pity that advantage was not taken of the advent of Wireless Telegraphy to redistribute the Morse symbols on the ideal basis here demonstrated.

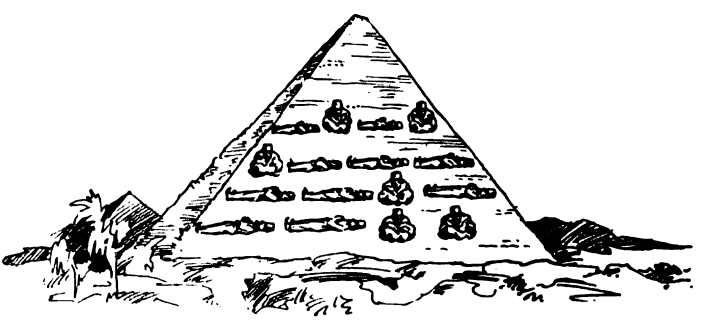

FIG. 6.

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English letters in order of frequency.	Present corresponding Morse Symbols.	Lines of divergence.	Ideal allocation in order of value.	Shewing where present symbol correct.
E	•		•	Yes
T	—		—	Yes
A	•—		••	No
I	••		•—	No
O	———		—•	No
S	•••		•••	Yes
N	—•		——	No
R	•—•		•—•	Yes
H	••••		••••	Yes
L	•—••		••—	No
D	—••		—••	Yes
C	—•—•		•••—	No
U	••—		—•••	No
F	••—•		••—•	Yes
M	——		•—••	No
G	——•		——•	Yes
W	•——		•——	Yes
K	—•—		—•—	Yes
P	•——•		•——•	Yes
V	•••—		—•—•	No
Y	—•——		——••	No
B	—•••		———	No
X	—••—		—••—	Yes
Q	——•—		——•—	Yes
J	•———		•———	Yes
Z	——••		—•——	No

CHART SHOWING DISTRIBUTION OF MORSE SIGNALS

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PERSONALITIES IN THE WIRELESS WORLD

LIEUT. BERTRAM HOYLE, M.I.E.E.

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THE subject of our biography, Lieut. Bertram Hoyle, is a native of Oldham, and obtained his technical and practical education at the School of Technology, Manchester, of which he is now an Associate. He also entered as a student at the Victoria University, Manchester, and in 1907 obtained the Certificate of that University in Technology, in the Department of Electrical Engineering; and also the Diploma of the School. He has since acquired the degree of M.Sc. Tech. of that University and is an A.M.I.E.E.

Having remained at the School for an extra year of study and research, he was for three years and a half in the service of, first, Messrs. Henry Simon, Ltd., Manchester; and, secondly, Messrs. S. Z. de Ferranti, Ltd., Hollinwood.

In 1911 Mr. Hoyle applied for and obtained a post of Assistant Lecturer and Demonstrator in Electrical Engineering at the School of Technology, Manchester, which he still holds.

Collaborating with Mr. Wm. Cramp, M.Sc. Tech., M.I.E.E., of Manchester, one of his former tutors, Mr. Hoyle presented to the Institution of Electrical Engineers a joint paper, based on their researches, entitled "The Electric Discharge and the Production of Nitric Acid," which won the award of an extra premium of £10; and an interesting abstract of his further researches appeared in our issue for September, 1915, under the title of "The Influence of Temperature and Pressure on the Sensitivity of the Carborundum Crystal Detector" [Vol. III., No. 30, New Series, page 356].

Mr. Hoyle has had charge of the design and erection of the wireless station with which the School of Technology is now equipped; and in peace time he gives lectures in that subject. He enlisted in the early part of 1915 as a motor cycle despatch rider, and after a short training was sent to France, where he served in that capacity at the front.

In September, 1915, however, he was gazetted Lieut. R.N.V.R., and, after necessary formalities between Admiralty and War Office, his transfer went through and in the following month he joined H.M.S. *Excellent*.

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The Telephone Receiver in Wireless Telegraphy

By W. H. NOTTAGE, B.Sc.

THE telephone receiver forms a very important part of most wireless telegraphic receiving circuits, forming as it does the last link in the chain between the transmitting and receiving operators—its function being the conversion of the electrical energy in the detector circuit into sound energy.

The efficiency with which this conversion of energy takes place depends on the electrical and mechanical design of the telephone itself and its suitability for the particular circuit with which it is associated.

The construction of the ordinary pattern of telephone receiver is well known.

For wireless telegraphy the watch pattern is universally used, as this form can be worn on the observer's head. It consists of a permanent magnet, usually made of two or more thin pieces of magnet steel. To these are fitted specially shaped pole-pieces round each of which a coil of wire is wound. The pole-pieces are placed so as to be as near to the centre of the diaphragm as possible.

The diaphragm is supported by the rim of the case opposite the faces of the pole-pieces, and at as small a distance from them as possible, without there being any tendency for it to be drawn into actual contact.

For the ordinary size receivers (diameters about $2\frac{1}{4}$ in.) the diaphragm is 10 or 11 mils thick, but for some well-known patterns, of which the diameter is $1\frac{3}{4}$ in., the diaphragm is only about half the above thickness.

The function of the diaphragm is two-fold. When a signal current passes through the coils the diaphragm is alternately attracted towards the poles and allowed to spring back, being thus set in vibration. This vibration is then communicated to the air in the neighbourhood, and reacts on the ear.

In the telephone receiver designed by Mr. S. G. Brown (see illustration on page 748) these two functions are separated. In place of a thin diaphragm, a stiff reed is fitted facing the poles, and this is set in vibration by the signal currents. The vibration is communicated to the air by means of a very thin aluminium diaphragm, which is of a conical shape, screwed to the reed at its centre, and fixed to the rim of the case by a circle of thin tissue paper.

This construction enables the reed to be brought much closer to the poles than an ordinary diaphragm can, a special screw adjustment being provided so that the distance can be regulated till the reed is just not pulled over by the magnets. The nearer the reed or diaphragm to the poles the greater the attraction for a given current and the greater the sensitivity of the telephone.

In addition to these forms, which depend for their action on electromagnetic effects, other forms of telephone receivers have been designed, which depend on

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quite different principles for working, but as they are not used to any great extent they will not be considered here.

The diaphragm of the ordinary receiver has a natural period of vibration of its own, and it will be most sensitive to a current whose period is the same. But the motion is, in general, damped, and the diaphragm, therefore, has a fair sensitivity for a range of frequencies on both sides of the natural period.

Telephones have been designed so that the diaphragm vibrates at a definite frequency with a much less damped motion. Such instruments have a sensitivity, which is high for currents of this frequency, but which rapidly falls off as the frequency changes. They are therefore termed "tuned receivers."

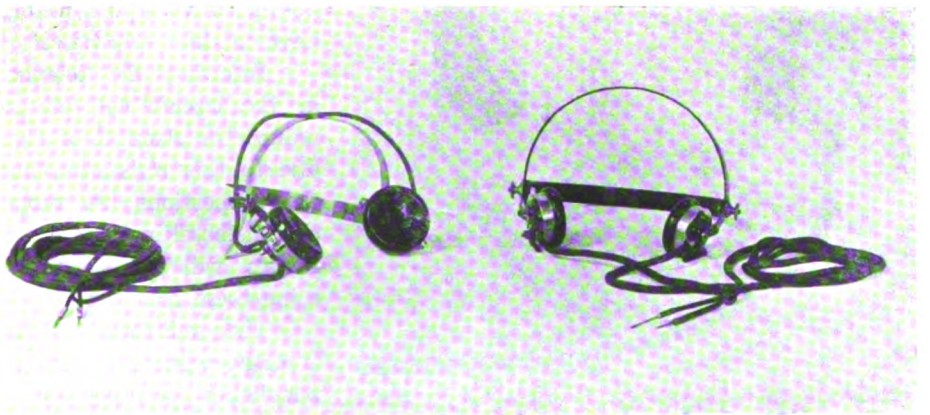
If the signal current were a sinusoidal wave-form, of unvarying frequency, the use of such special forms of telephones would present the advantage of tuning out all but the required signals.

The ordinary signals given by transmitters working by musical or quenched sparks are far from being of sine wave form, so that the tuned telephone has no advantage, since it rejects a considerable part of the energy of the signal besides destroying the distinctive character, due to harmonics, by which it can be picked out from other signals.

The sensitivity of a telephone receiver varies with the frequency of the signals acting on it. In THE WIRELESS WORLD for September, 1916, a curve is reproduced on page 444, showing the change in sensitivity for a pair of telephones as measured by the U.S. Bureau of Standards. The sensitivity is measured by the voltage at the terminals (or the current through the coils) required to give signals of a certain standard of audibility.

It is evident that the results of such a test give the sensitivity of the telephone and observer's ear in combination.

It is noticed that as the frequency gets higher the voltage required becomes smaller, so that the sensitivity increases rapidly with the frequency for the range of frequencies used in the test. Beyond a certain value the sensitivity will decrease,



TWO MODERN TELEPHONE RECEIVERS USED IN WIRELESS WORK. THAT ON THE RIGHT HAS ALUMINIUM CASES AND EBONITE-COVERED HEADBANDS.

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since most people are unable to hear notes of higher frequency than about 20,000 to 40,000.

The telephone diaphragm, having a natural period of vibration, which, for usual patterns, is about 1,000 periods per second, will show a decreasing sensitivity above this point.

By tuning the electrical circuit of the telephone to the frequency of the spark increased sensitivity is obtained without losing all the energy of the harmonics. This is effected by connecting a condenser in parallel with the coils.

For exact tuning, or where a variety of notes are likely to be required, a variable condenser may be used, but in most cases a fixed condenser will increase the strength of signals for a considerable range in frequencies.

The capacity of the condenser is obtained from the formula :

$$4\pi^2 n^2 LK = 1,$$

where L is the inductance of the telephone in henrys ;

K is the capacity in farads,

n is the frequency in periods per second.

In order that a telephone receiver should give the maximum effect when associated with a particular circuit it is necessary that its windings should be suited for connection with it.

TELEPHONE RECEIVER OF S. G. BROWN WITH REED AND SEPARATE DIAPHRAGM.

Thus, if the current in the circuit be small, due to the high resistance of the various parts, the telephone coils should have a large number of turns in order that the small current may produce a large enough magnetic effect. This large number of turns will naturally have a high resistance.

Inserting the telephones in the circuit will naturally reduce the strength of signals due to this resistance, but if the proportions are properly chosen the ultimate strength of signals will be greatest by using these receivers.

The resistance, of itself, is of no value in making the telephones suitable for the circuit, but as a matter of convenience of description it is

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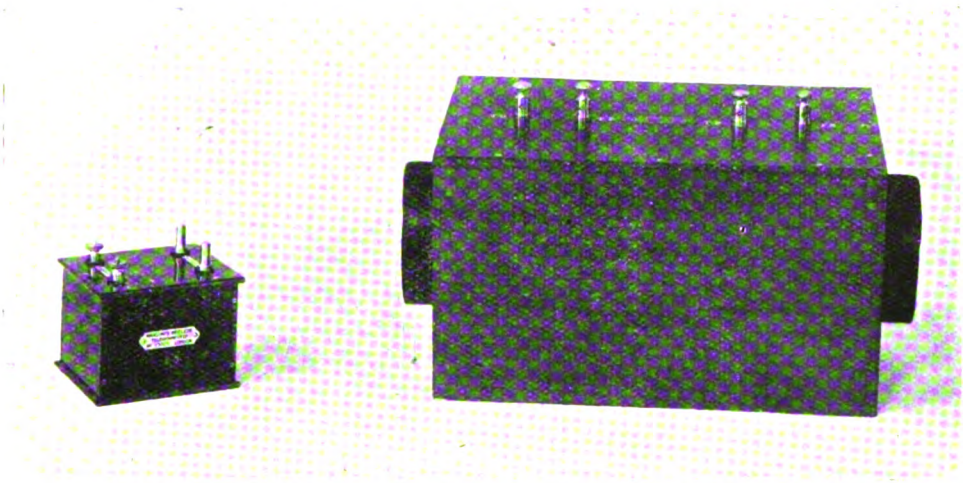

TELEPHONE TRANSFORMERS. THAT ON THE RIGHT IS OF THE TYPE USED IN HIGH-POWER STATIONS.

usual to describe telephones by their resistances, as "high or low resistance telephones."

For a circuit where due to its low resistance a large current is obtained the telephones should have fewer turns, in order that their resistance may be kept within reasonable limits.

In place of high-resistance telephones a telephone transformer may be used in conjunction with low-resistance telephones, and has advantages in many cases.

In order to detect very minute currents the number of turns of wire required on the telephone coil becomes so great that a very fine wire must be used. This increases the difficulty of the manufacture, and hence raises the cost. Moreover, the thickness of insulation required cannot be reduced in the same ratio as the diameter of the wire, so that a coil of fine wire will have a smaller ratio of winding space usefully occupied with the conductor to what one wound with larger wire will have.

In the telephone transformer there is no restriction as to the size of the coils as there is in a head-gear telephone, and the proportions are chosen so that wire of a reasonable diameter may be used.

It is usual to use a central core of soft iron wire, and to wind the "high-resistance winding" over this, the "low-resistance winding" being outside. The dimensions may vary within wide limits, the size being determined by the relative importance of efficiency and compactness for the circuit.

In a high-power station the telephone transformer may be of large size, but in an ordinary receiving circuit one of about 4 or 5 in. side is the most convenient size.

It is usual to connect condensers in parallel with each winding of the transformer, their values being given by the formula above, the frequency to which the transformer is tuned being that of the average note likely to be received.

By using variable condensers exact tuning to the note is possible, with a consequent increase in selectiveness.

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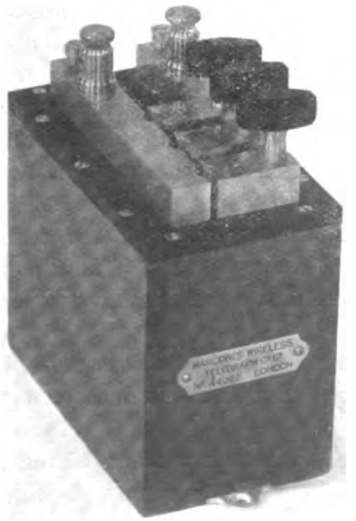
The condensers used for tuning telephones or transformers must have a high efficiency. Condensers of low efficiency, which show absorption, give the note heard a muffled sound, due to the fact that the higher harmonics are reduced in a greater proportion than the fundamental, in addition to the actual strength of signals being reduced. It is usual to use mica condensers where fixed capacities are used; for variable capacities ebonite disc condensers are suitable.

The telephone-transformer is practically essential in circuits using magnifying valves, since the place for the telephone is in the same circuit as the high-voltage battery used for applying a potential to the sheath. By using the transformer all danger of shocks from accidentally touching the terminals of the instrument is obviated and the electrostatic capacity effects are reduced.

In carrying out tests on strength of wireless signals under various conditions, in many cases much valuable information can be obtained if a large number of stations can record observations at the same time. It is obviously impossible to provide all these stations with the delicate instruments which find a place in large laboratories, and in most cases it is only possible to use the receiving apparatus with the smallest possible additions. This allows stations having other work to do to take part in the tests as occasion offers.

One method for estimating the relative strength of signals is to connect a resistance in parallel with the telephone winding and adjust it until the signals are just audible, the standard adopted being the point when dots and dashes can just be distinguished.

This standard is not a constant quantity, since it depends on the sensitivity of the observer's ear, which varies from time to time, and also on the freedom from interfering sounds which render the distinguishing of a readable from an unreadable signal more difficult.



A TELEPHONE CONDENSER.

The relative strength of two signals is measured by the ratio of the currents required to produce them in the telephone.

When the telephone is shunted by a resistance, R, the current flowing through the telephone is given by

$$I_t = I_o \frac{R}{\sqrt{(R+R_t)^2+(2\pi n L_t)^2}}$$

where I_o = current in leads from detector to telephone and shunt;
R_t = resistance of telephone in ohms;
L_t = inductance of telephone in henrys;
R = resistance of shunt.

R_t and L_t must be measured at the frequency n of the signals being used.

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When the shunt is removed the total current from the detector should be unchanged, as otherwise the conditions will be different and no comparison can be made:

For this $I_x = I_o$ where I_x is the current in the unshunted telephone.

Therefore the ratio of the two currents is

$$\frac{R}{\sqrt{(R+R_t)+(2\pi n L_t)^2}}$$

and by comparing the values given by this formula for different signals their relative strength may be estimated.

In the above formula it has been assumed that the resistance and inductance of the telephone are constant quantities for any particular frequency.

Since the coils are wound on the iron pole-pieces the inductance will depend on the current flowing through them, and therefore will not be constant.

Drs. Kenelly and Pierce in a paper on "The Impedance of Telephone Receivers as Affected by the Motion of their Diaphragms" * give measurements of the inductance and resistance of certain telephone receivers at various frequencies, the voltage at their terminals being kept constant. They show that not only do these quantities vary with the frequency, but they have different values according as the diaphragm is free to vibrate, or fixed so as to be unable to move.

Terming the values obtained with the diaphragm fixed the "damped" values and the others the "free" values, the difference between them is termed the "motional" inductance or resistance respectively.

From curves given in the paper it is seen that the motional resistance reaches a maximum value at a point before the natural frequency of the diaphragm is reached and passes through zero at the natural frequency to a minimum at a slightly higher value.

The reactance, on the other hand, passes through a sharp minimum at the natural frequency.

The following table, taken from one given in the paper referred to, will show these variations.

RESISTANCE AND REACTANCE OF A WATCH CASE RECEIVER AT DIFFERENT FREQUENCIES WITH 0·3 VOLT AT TERMINALS OF RECEIVER.

Frequency.		Resistance, Ohms.			Reactance, Ohms.		
Cycles per second.	Radians per second.	Free.	Damped.	Motional.	Free.	Damped.	Motional.
n	ω	R'	R	$R'-R$	x'	x	$x'-x$
451	2,834	135	136	— 1	115·7	118·5	— 2·8
653	4,102	163	160	3	150·3	149·5	·8
849·5	5,340	194	184	10	172·5	174·7	— 2·2
903	5,674	212	189	23	160	180·5	—20·5
923	5,800	192	191	1	137·8	182·5	—44·7
945	5,938	168	193	—25	160·1	184·5	—24·4
1,020	6,408	188	200	—12	191·1	191·7	— 0·6
1,250	7,854	214·5	220	— 5·5	210·6	212	1·4

* *Proceedings of the American Academy of Arts and Sciences*, Vol. XLVIII, No. 6, September 1912.

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The natural frequency of the above receiver was 923 vibrations per second, and its direct current resistance 81·4 ohms.

In this investigation a sine-wave current was used, but the actual signals in the telephone of a radiotelegraphic receiving circuit are not of this form, so that the values of resistance and inductance would differ somewhat for the two cases.

In measurement of the strength of signals by the shunted telephone method it is obvious that inserting the direct-current values of inductance and resistance will lead to large errors, and therefore the values measured at the frequency of the signals should be used, the current strength being kept as near that of the signals as is possible for the particular method of measurement used.

In another paper by Dr. Kenelly and Mr. H. O. Taylor the results of an investigation of the motion of the diaphragm at various parts of its surface are given.

A diaphragm clamped at the edge is capable of vibrating with a maximum amplitude at its centre diminishing to zero at the clamped edge, or with one or more nodal circles or nodal diameters.

The first mode of vibration is the fundamental, and has the lowest period of vibration of the series. The results of the investigation quoted showed that this fundamental mode was alone obtained for ordinary telephone diaphragms set in vibration electrically.

Further Notes on "Jungleland"

By a coincidence at the same time that we published our article on "Wireless *versus* Wire in Jungleland" there appeared in our contemporary, *The Wireless Age*, an article explaining how the great network of wireless stations in Brazil serves that country. If you will take an atlas in hand (says Mr. J. L. Barttro in the article in question) you will be able to follow to better advantage the progress of the wireless as I learned it while employed in radio in Brazil. Beginning at Para at the mouth of the Amazon, radio stations have been erected as far as the Pacific Coast, with installations at Manaos, Santarem, Iquitos, Quito, Lima, Porto Velho, Senna Madureira, Rio Branco, Cruzeiro de Sul and Xapury. For your information it may be well to state that Porto Velho, or, wirelessly speaking, P.V., is at San Antonio Falls, 700 miles up the Madeira River, and the balance of the southern stations are in the Acre rubber district, located between the Purus River and Madeira.

Messages from the government officials in Rio de Janeiro are transmitted to their subordinates along the western border in large volume. This is especially true of the wireless and of the relay from Para on, 2,500 to 3,000 words being the average traffic business transacted in four hours from that place to Senna each morning. After making the river trip from Para to Porto Velho, which takes two long, hot, tiresome weeks, or the month's journey from Para to Senna up the smaller rivers, one is particularly impressed with the speed and ease of communication effected by wireless. As for Rio Branco and Cruzeiro, it is fatiguing even to think of the time and unpleasant features involved in a trip to them. Mail does not arrive with the morning sun in these places. But the morning messenger does bring the telegrams to the sub-prefect in his little thatched office in the rubber wilds.

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Digest of Wireless Literature

Lord Kelvin and Wireless.

In a lecture on "Some Aspects of Lord Kelvin's Life and Work," delivered by Dr. Alexander Russell before the Institution of Electrical Engineers on November 9th, an interesting review of the work of this famous scientist was given. Speaking of Lord Kelvin's researches in connection with electric oscillations, Dr. Russell said that in 1853 Thomson read an epoch-making paper on the "Oscillatory Discharge of a Leyden Jar," to the Glasgow Philosophical Society. Six years previously Helmholtz had discussed a puzzling phenomenon he had noticed when a steel knitting needle was magnetised by the discharge current from a Leyden jar. In some cases the needle was left magnetised with the north pole at one end, and sometimes with the north pole at the other. If the discharge were oscillatory this would explain these results. Thomson proved mathematically that this was true in certain cases, and obtained a formula by means of which the rapidity of the oscillations can be computed. He suggested also that an experimental verification of this might be obtained by means of Wheatstone's revolving mirror. Fedderson did this in 1859. The invention of the oscillograph has enabled us to study these discharge currents in detail and prove that Thomson's theory is very approximately correct. The great practical importance of this paper lies in the fact that it led many physicists to study the problems of oscillatory discharge most carefully, and wireless telegraphy was the direct although unexpected outcome of their labours. It has to be remembered, however, that Thomson's theory is not complete. Of the energy originally stored in the jar we know that some is radiated into space. In many cases this amount is negligibly small, and Thomson's theory is directly applicable. But he did not show how the radiated energy could be taken into account or state the limitations of his formulæ.

Another section of interest to radiotelegraphists is that connected with Lord Kelvin's work on "High Frequency Resistance." In his presidential address to the Institution in 1889, Thomson explained the variation in the density of a high-frequency current in a cylindrical conductor over its cross-section. He supposed that the conductor was either at a great distance away from the conductor for the return current or that it was the inner conductor of a concentric main. He points out that at very high frequencies the current is practically confined to the surface of the conductor. This result might have been deduced from Willoughby Smith's experiments on the screening effect of metals. He gives a formula for the effective resistance of the conductor and also a table calculated by Magnus Maclean of the numerical values of the functions in terms of which the solution is expressed.

* * * * * *

Crystal Detectors.

At a recent meeting of the Physical Society at the Imperial College of Science a paper entitled "The Influence of the Time Element on the Resistance of a Solid Rectifying Contact" was read by Mr. D. Owen, B.A., B.Sc.

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The resistance at a solid rectifying contact, and consequently the exact shape of the resistance characteristic, depends upon the time for which the testing current is allowed to flow. A series of characteristics were given corresponding to durations of contact extending over the range one forty-thousandth of a second to 30 seconds. The following conclusions were drawn :—

1. That the variation of resistance with voltage may be attributed entirely to thermal effects.

2. That the characteristic obtained by applying the testing voltage for one-hundredth of a second is, at moderate voltages, materially the same as that which would be found at the expiry of a period of the order of a millionth of a second.

3. That the sensibility of a wireless receiving circuit (in which the rectifying contact is used) does not differ very appreciably from that deduced from a slow period characteristic.

4. That an important fraction of the contact-resistance resides in a stratum of molecular thickness at the interface of the two elements of the contact ; and that it is in this region alone that rectifying action at very high frequencies is effected.

Professor G. W. O. Howe thought the experimental method of Mr. Owen was the correct way to tackle the problem of high-frequency phenomena, and was preferable to taking oscillograph records at low commercial frequencies and attempting to deduce from them what will happen at very much higher frequencies. What is the limit to the number of times per second that the ball may be struck for the results still to apply to one impact only ? From one point of view the results were disappointing, inasmuch as it had been necessary to introduce a mysterious stratum of molecular thickness, and the problem arises as to what these layers consist of ; what are their properties, and why is the thermal effect largely confined to them ?

Dr. H. S. Allen asked if any attempt had been made to remove surface films from the contacts. Professor Milikan had recently obtained very simple results in photo-electricity by working in a high vacuum so as to remove all films of moisture. Could this not be done in Mr. Owen's experiments ?

Dr. Eccles said that the subject of contact resistance was of wide importance, apart from its application to electric wave detectors. It had been investigated by Wheatstone and Heaviside in other connections—microphones, for example. It was important also in connection with the contacts at dynamo brushes. There had always been a desire in wireless telegraphy circles for high-frequency characteristic curves. Doubtless, if oscillograph records could be obtained for frequencies of 10 seconds, they would be very like what Mr. Owen gets by his point to point method. He would have been glad if the author had tried similar contacts, *e.g.*, two carbons, two galenas, or even two metals. In these cases there would be no thermo-electric phenomena to confuse the issue. He was not convinced on the question of molecular layer. The author states that " in actual practice the mean diameter of the area of a good rectifying contact is, as a rule, far greater than 10^{-4}cm." Now, if one pictures a piece of metal resting on the zigzag surface of a crystal, it is obvious that actual contact will only occur at points and ridges, and it is surely impossible for anyone to assert what the order of the area of contact is. He preferred to think that the effects were due to the heating of the surface layers of the stuff, due to concentration

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of the current flow into the narrow regions where actual contact exists. Usually the harder the crystal the better the rectification obtained, due possibly to the greater concentration of current in the smaller and sharper contact points. He thought perhaps too much stress was laid on the high frequency characteristic. When an oscillation passes through the contact of a crystal touching a metal plate, it is the after-effects of the heat developed which produce the thermo-electric currents that affect the telephone. Therefore, while of scientific interest, the high-frequency characteristics are not very essential from the point of view of wireless telegraphy.

Mr. F. E. Smith thought Dr. Allen's suggestion a valuable one. About 14 years ago a paper was read to the Society showing that films of liquid remained attached to solids even up to temperature of 300° C.

Mr. Owen, in reply to Professor Howe, thought there was no mystery connected with the contact layer. We cannot assume complete continuity of material at a contact, as in a weld, since there is never any difficulty in pulling the elements apart.

With respect to the repeated impacts, the time between the impacts was never less than about 8,000 times the duration of contact. The point raised by Dr. Allen required investigation. It was scarcely necessary for him to reply to most of Dr. Eccles' remarks, as they really constituted an independent contribution to the subject.—(*Electrician* report.)

* * * * * *

Radiation Simply Calculated.

In our American contemporary *The Electrical Experimenter*, C. L. Whitney recently published an interesting paper from which the following notes are extracted:

The watts radiated from a flat-top aerial may be found from the equation:

$$P = 1578 \cdot 2 \frac{h^2}{\lambda^2} I^2.$$

Where:—P = power radiated in watts.

h = height of aerial (in feet).

λ = length of emitted wave (in feet).

I = ampères, as measured by hot-wire ammeter in aerial circuit.

This formula is used where the antenna capacity is mostly in the flat-top. For example:

Supposing we have a flat-top aerial 100 feet high with leads brought down from the centre. Our wavelength is, say, 600 metres, or approximately 2,000 feet. The hot-wire ammeter reads 5 ampères.

Then $$P = 1578 \cdot 2 \left(\frac{100^2}{2000^2} 5^2 \right)$$

or $$P = 1578 \cdot 2 \frac{10{,}000}{4{,}000{,}000} 25 = 88 \cdot 6375 \text{ watts.}$$

Therefore with a flat-top aerial 100 feet high on 600 meter wave-length, we are radiating approximately 88 watts.

The watts radiated from a vertical aerial is given by the formula:

$$P = 640 \frac{h^2}{\lambda^2} I^2.$$

This formula is applied in the same way as the first.

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Now we can calculate the power radiated in still another way, as long as we know the radiation resistance of the aerial, and the number of amperes.

$$P = Ra\ I^2.$$

Where :—Ra = radiation resistance in ohms.

I = Ampères, measured by hot-wire ammeter in ground or aerial lead.

To find the approximate radiation resistance (Ra) of a flat-top aerial we use this formula :

$$1600\ \frac{h^2}{\lambda^2} = Ra \text{ (in ohms)}.$$

Where :—h = height of aerial (in feet).

λ = length of emitted wave (in feet).

We can increase the radiated power by increasing the height of the aerial. Thus if our aerial was 200 feet high instead of 100 feet and the hot-wire ammeter reading remained the same (5 ampères) we would radiate 4 times as much as before, or about 375 watts.

Radiation may also be increased by increasing the number of wires in the flat-top, but the most effective way to increase the radiation (and incidentally the range of the station) is to increase the height of the aerial. We could build an aerial say 100 feet long at a distance of about 10 feet from the ground, and when we connect our transmitting set to this the hot-wire ammeter will show a higher reading than when the set was connected to a high aerial. However, by the above formulæ we can readily see that the power radiated (watts ; not ampères alone) is not high and naturally the distance we can transmit is also curtailed very much.

It is now plain why in some cases one station (call this station No. 1) radiates say, 8 ampères and has a range of say, 200 miles, while another station (call this station No. 2) radiates, say, 5 amperes and works 300 miles as easily as station No. 1 works 200. If it is noticed carefully just how each station's aerial is built and how the leads run (if parallel to iron masts, stacks, etc., in case of a station on a ship) it will be found that the aerial of station No. 1 is either low, or that the leads run parallel to some grounded object and therefore although 8 ampères leaves the station, much of it is lost to the grounded objects. Again the aerial may be low and thus the watts radiated is low, although the hot-wire ammeter shows a high reading. The practice of using hot-wire ammeter readings to compare two or more stations is very misleading, as becomes apparent.

* * * * * *

A SIMPLE TEST FOR MOISTURE IN TRANSFORMER OIL.

While the only thorough test for suitability of oil for transformers and oil switches can be made with high-tension testing apparatus, very good indications of the presence of moisture have been obtained by J. K. Mackie, superintendent of the Connecticut Power Company, as follows : A sample of the oil to be tested is drawn from the bottom of the transformer, oil switch or storage tank. (Samples from the upper parts of the tank are not considered as suitable for the test, as water is heavier than oil and usually collects at the bottom.) In the sample thus taken is placed powdered anhydrous copper sulphate. If moisture is present the copper sulphate will be dissolved, producing a blue colour that will diffuse through the oil if moisture is in suspension. - (*Electrical World.*)

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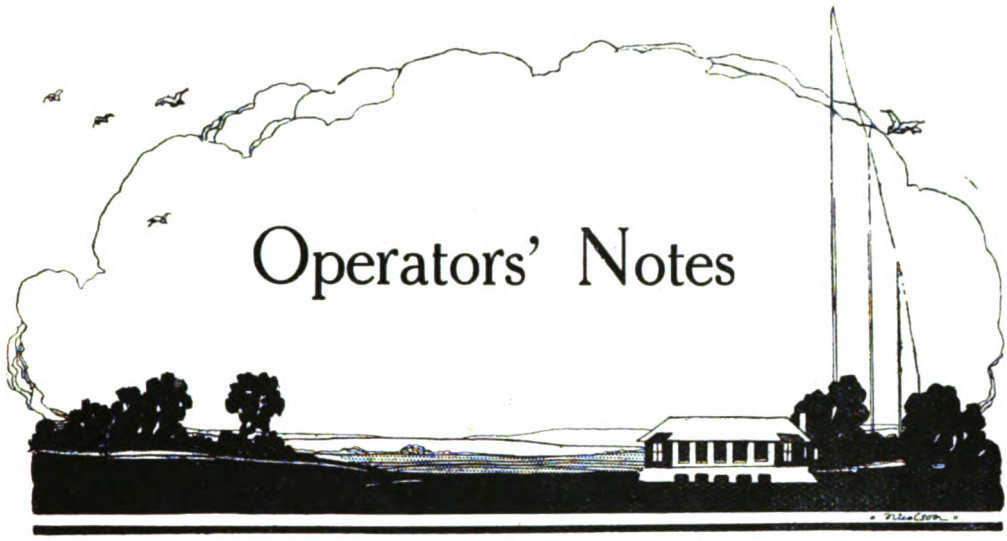

Some Notes on the Maintenance of Accumulators

By WILLIAM PLATT

SPACE is most valuable on shipboard, and the ship type accumulator has been especially designed to occupy the smallest possible area and give the maximum efficiency. As most operators are aware, the type of cell usually employed is known as the "lead" accumulator, and is made up of four specially formed positive and five negative plates fitted in a lead-lined teak container. Three different types are in use on British steamships carrying Marconi installations—viz., the PW 4 type, manufactured by the Chloride Electrical Storage Co., the "Ship type," manufactured by the Electrical Power Storage Co., and the P.P., manufactured by the D.P. Battery Co. While the process of manufacture may differ considerably, each of these types is known as a "lead" accumulator and, apart from a slight difference in capacity and specific gravity, which must be taken note of, they call for the same general treatment. When cells are sent out from makers, in nearly all cases an instruction sheet accompanies them. This sheet gives figures indicating normal charging rate, maximum voltage, and maximum specific gravity readings. The switchboard charging arrangement is in all cases standard. In series with the dynamo there is a wire resistance of 5 ohms and two 50 c.p. carbon lamps (in parallel).

Suppose we have a battery of 12 cells to charge and these cells show a voltage of 1·9 each, giving 22·8 volts for the whole battery. To find the charging rate through the marine switchboard we must know the voltage of the dynamo, the resistance in the marine switchboard, and the voltage of the battery to be charged. For practical purposes we can ignore the internal resistance of each cell, as this varies somewhat and is in most cases small. To find the resistance of the 50 c.p. carbon filament lamps we must calculate as follows. A carbon filament lamp takes from 3 to 5 watts for each c.p. of light given. Let us, therefore, take the mean of this and say 4. Now 4 times 50 = 200, therefore our 50 c.p. lamps are taking 200 watts to light them at full power. Now volts multiplied by ampères give watts, so if we divide the figure 200 by our charging pressure we shall get the ampèrage taken by the lamps—*e.g.*,

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with a dynamo giving 100 volts pressure the current taken by each lamp would be $\frac{200}{100}=2$ amps. This 4 amps is often thought to be the charging rate when using the marine switchboard, but this is wrong, as it does not take into consideration the voltage of the battery to be charged, nor is the 5 ohms of wire resistance in the board reckoned with. By Ohm's law we find that each lamp has a resistance of 50 ohms. Then 2 lamps in parallel will have a resistance equal to the reciprocal of the sum of the separate reciprocals—*i.e.*,

$$\frac{1}{50}+\frac{1}{50}=\frac{2}{50}=\frac{50}{2}=25 \text{ ohms.}$$

Then we have resistance in circuit equal to $5+25=30$ ohms. When we put the accumulators on charge we connect up positive of dynamo to positive of accumulator battery and clearly then the 100 volts pressure must be decreased by the voltage of the cells which represent a back E.M.F., therefore our available charging pressure is $100-22{\cdot}8$ (the voltage of the battery to be charged) $=77{\cdot}2$ volts. Now to find charging current we again use Ohm's law $I=\frac{E}{R}$. In our case $I=\frac{77{\cdot}2}{30}=2{\cdot}5$ ampère charging rate. This rate is small for such a type of cell, and the only time at which it might be used is when accumulators are discharged regularly at a correspondingly low rate. Now some of the switchboards were designed at a time when accumulator batteries were frequently used in connection with working the induction coil, and the discharge rate was a low one. Also at that time 8-cell batteries were used. This arrangement had two important differences—viz., a correspondingly lower discharge rate when working coil and higher charging rate when charging from dynamo. More recently, however, when International Regulations were framed and it was ordered that accumulator batteries should not be used save in cases of emergency, it was necessary to make some arrangement whereby accumulator batteries could be properly discharged and charged up again in a comparatively short time, say, such as the duration of a ship's stay in port. Accordingly an auxiliary panel was designed for use with the marine switchboard, not only to give an increased charging rate, but also to provide a means of discharging the battery. This panel is made up of a 3-ohm wire resistance, and the connections can be explained as follows :—

Firstly, it is in series with the 5-ohm resistance of the marine switchboard and the accumulators, but it is in parallel with the lamps of that board. Now the lamps have, as we know, a resistance of 50 ohms each, or 25 ohms together in parallel. Our 3-ohm resistance will more or less be a " dead short " across these lamps, and in any case will represent 3 ohms or less resistance against 25 ohms without the auxiliary panel. Hence the resistance in circuit when using extra panel is 8 ohms—5 in marine board and 3 in panel. Taking the same figures as before, having $77{\cdot}2$ volts and 8 ohms, therefore the charging rate will be nearly 10 ampères. Suppose now the cells are fully discharged, that is, the voltage has dropped to $1{\cdot}8$ per cell, and the capacity of each cell is 80 ampère-hours, then at a charging rate of 10 ampères it will be necessary to charge for 8 hours before cells will gas properly and a couple of hours' further charge to allow for charging losses.

(To be continued.)

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The Calculation and Measurement of Inductance and Capacity*

A New Volume of First Importance to Radio Workers

In the early days of wireless telegraphy, when the transmission of a message over a distance of five miles was counted a wonderful achievement, theorists were working largely in the dark, and the practical worker with his methods of trial and experiment held the field. Many of us can remember the days when jiggers were wound in a peculiar shape, not because any formulæ or calculations indicated that results could best be achieved that way, but simply because it chanced to be a method which " worked." And many experimenters were loath to give up their crude and cumbersome home-made appliances for fear that the neater and more compact factory-produced apparatus would fail to give the results desired.

Such is usually the position of a new science before a great accumulation and classification of facts gives the theoretical worker the raw material from which to produce and check his formulæ. In the 20 years which have elapsed since the first commercial wireless apparatus was set before the world, a great host of workers have collected a vast store of important observations, and scientists have so sorted, checked, and compared them that we now see order, where formerly was disorder only, with the result that the science of radiotelegraphy is now firmly established upon a sound mathematical basis.

Such thoughts as these occur to us on opening the volume on *The Calculation and Measurement of Inductance and Capacity*, which the well-known radio worker, W. H. Nottage, B.Sc., has just written. It is the first book devoted entirely to this subject, and brings together for the first time many of those classified facts and formulæ to which we have alluded above. Wireless telegraphy being a science of oscillations, and oscillations depending for their production upon the proper arrangement of inductance and capacity, it needs no deep knowledge or wide reading to see how important such a book as this must necessarily be. Both professional and amateur wireless workers are almost daily called upon to make calculations such as those which are dealt with in the book before us, and it is a fact beyond dispute that much needless work and even more regrettable error has arisen from the ignorance of the correct formulæ to use, and the absence of such a book as this, where the special means of calculation for particular circumstances can be found.

As the author says in the preface, the object of this book is to present in a convenient form the more generally useful formulæ and methods of measurement of inductance and capacity. There have been considerable developments in recent years in the design of instruments intended for the calculation of inductance and capacity, and it is hoped that the descriptions in the book may prove of service to

* *The Calculation and Measurement of Inductance and Capacity*, by W. H. Nottage, B.Sc. London Wireless Press, Limited. 2s. 6d. net.

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those engaged in this work, especially as some of these instruments do not appear to have yet been noticed from the various text-books dealing with the subject. In Chapter I. we have the meaning of inductance explained, and the principles on which the calculations are based. The calculation of inductance of a straight wire and a coil are then treated from an elementary standpoint, and the difference between high-frequency and steady current values discussed. A number of important formulæ for the self-inductance of a straight wire and a straight tape next follow, after which we come to the treatment of mutual inductance of two wires for tapes. Then step by step we proceed to the considering of the inductance of circular wires, circular tapes, squares and rectangles, and other geometric forms. And next, what is very important from the standpoint of the wireless worker, the self-inductance of a single layer coil.

In the half-forgotten days of peace, when poles were erected in gardens, on roofs, against the walls of out-buildings, and in other places, when the thin wires of amateur aerials appeared almost as frequently as threads of gossamer upon the countryside, we were continually receiving in our letter basket questions such as:

"What is the inductance of a coil 6 inches long and $2\frac{1}{2}$ inches in diameter?"

"What wave-length can I receive with $\frac{1}{2}$ lb. of enamelled wire wound on the former 7 in. by 3 in.?"

"What size wire must I use on my tuner to receive Eiffel Tower?"

And so on, depending on the knowledge and experience of the particular amateur. It seemed to make little difference when we pointed out from time to time that the inductance of the coil depended not only upon the diameter and length of the coil, but on the number of turns to the inch and the space between them. One fact, however, stood out above all others on going through our daily correspondence, most amateurs needed to have placed before them the main facts regarding tuning coils and their inductance. Here in Mr. Nottage's book we have just what the serious amateur has been waiting for for years. On page 18, for instance, speaking of coils without iron cores, the author gives Professor Nagaoka's formulæ, explaining its uses and also its limitations. This enables the investigator to calculate the inductance of a single layer coil of wire with a precision sufficiently great for most practical purposes. For making approximate calculations of the inductance of a coil, a table is given from which the inductance of coils ranging from four to ten centimetres in diameter and from one to thirty-four centimetres long have been worked out. Another highly useful table gives a number of turns per centimetre for coils wound with various covered wires.

After dealing with coils with iron cores, we come to the treatment of mutual inductance. There are a number of formulæ for the mutual inductance of single layer coils, the one to use depending, says the author, on whether the coils are concentric or at a distance apart, or whether the inner is higher than the outer, etc. These formulæ are mostly very complicated, and if, for example, the curve of the mutual inductance between two coils of various relative positions was required, the work involved would be very great. To overcome this difficulty Mr. Nottage has devised a simple graphic method by which results of fair accuracy can be obtained with a small amount of work, and it is very suitable for plotting a curve of the nature referred to.

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Chapter II. deals with the calculation of capacity and the various forms of condensers, fixed and variable. As in the case of inductance, full descriptions are given of the various methods of calculation and the various factors which have to be taken into consideration in special cases. The important contribution to the science of radiotelegraphy made by Professor Howe in his papers for the British Association on "The Capacity of Radiotelegraphic Antennæ" are next treated, and we remark that the author is right up to date in dealing with Professor Howe's papers presented to Newcastle only a few months ago.

Chapter III. is devoted to the measurement of inductance, and explains the use of the Fleming-Anderson bridge, the Maxwell bridge, and the bridges of Butterworth, Owen and Hay. The Drysdale alternating current potentiometer is also considered. Other forms of apparatus dealt with in this chapter are Professor Lee's bridge, the Campbell inductometer, the Ballistic galvanometer, Grassot fluxmeter, and Drysdale's combined inductance and capacity testing bridge.

In Chapter IV. the calculation of capacity comes in for the same careful treatment, Wein's series resistance bridge, Fleming and Drysdale's bridge and other methods not being omitted, and by the time he reaches this portion of the book the reader will be truly unobservant if he fails to note the great care and thoroughness with which the subject has been treated.

Chapter V. is devoted to high-frequency measurements, and Chapter VI. to appliances for use in measuring inductance or capacity, including the testing receiver, the vibration galvanometer and the Sumpner alternating current galvanometer, whilst in an appendix we find a number of useful tables. The print is clear, the diagrams well reproduced, and the binding and general make-up of the volume excellent. Many books have been said to be indispensable to the wireless worker, but this treatise above all is entitled to be so designated. We can strongly recommend the book to all workers, wireless or otherwise, who at any time need to undertake calculations relating to either inductance or capacity.

Administrative Note

ALASKA.

The Director of Naval Communication has announced that, effective October 1st, 1916, radio rates to conform as near as possible to the rates of the Washington-Alaska military cable and telegraph system effective that date, will be placed in effect *via* the naval communication service in Alaska. All traffic to or from ships at sea will be prefixed "Radio." Cable count will be used. Ten-word minimum will be required. Naval radio stations at St. Paul, St. George, Dutch Harbour, Kodiak, Cordova and Sitka will apply a 6-cent coast tax. Service between any point in Alaska reached by the naval communication service or the Washington-Alaska military cable and telegraph system and any of these stations will carry a rate of 5 cents. per word additional. This will also include North Head or Seattle for local delivery or for transfer to other systems to reach points beyond these systems. The traffic may be routed *via* either the naval communication service or cable service or both. This rate does not include other line charges, which should be added if it is necessary to employ other lines to reach destination.

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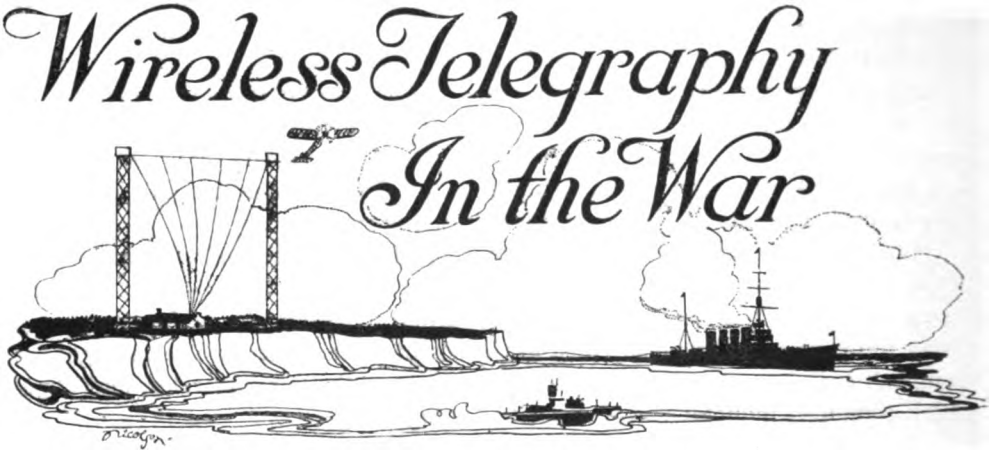
Wireless Telegraphy In the War



WAR AS A TEACHER.

WAR is a great teacher of ethnology, geography and history. We wonder how many people before the recent happenings in Roumania realised that the territory of our Ally forms the *locale* of the old Roman colony of Dacia, or that the Roumanians themselves are not only descended from these Roman colonists, but actually speak a language of Latin origin. The piers of a bridge constructed by the Romans are still to be found in the neighbourhood of Orsova ; whilst Constantza, which recently underwent the sorry experience of German occupation, is the modern representative of Tomi, the Dacian town to which the Roman poet, Ovid, was exiled for his too successful practical exposition of the theories which form the theme of his famous poem " De Arte Amoris," *The Art of Love*. This port of Tomi (or Constantza) excited a good deal of interest amongst wireless operators and newspaper correspondents who found themselves in Turkish waters during the Balkan struggles of five years ago. At that time the Roumanian wireless station there located proved of considerable assistance to news-getters, who had to contend with a prohibitively rigid Turkish censorship. One resourceful correspondent managed to elude Ottoman supervision by boarding one of the Roumanian mail steamers lying off the Seraglio Point (Constantinople), and persuading the ship's operator to send his newspaper messages by wireless to Constantza, whence they travelled without hindrance to England.

It was mainly with the view of keeping in touch with these vessels, belonging to the Roumanian Royal Mail Line, that the land station was erected. The installation, in peace time, consisted of medium power machinery, working a system known as the Branly-Popp. We recently pointed out that the different radio stations not infrequently possess special " Notes " of their own, and this was very markedly the case in this particular instance. Its spark was of the peculiar variety aptly described by our French friends as *étincelle rare*. In fact the frequency was so low that the separate sparks could almost be counted, there being only three or four of them to the dot. The Roumanian vessels (one of which was named the *Dacia*) also carried apparatus of the same system, and the ship's operators appeared unable to

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communicate with any vessels other than those belonging to their own line and with the shore station at Constantza.

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A WIRELESS MAN CAMPAIGNING IN AFRICA.

Some of the most interesting items of news in connection with the various British Expeditionary Forces have been contributed, not by professional newspaper correspondents, but by private letter-writers. Every now and again the recipients of such correspondence have placed their epistles at the disposal of the Press and, in the case of war-zones, without some specific reason for so doing, the Press Bureau does not veto their appearance. Pioneer J. H. Rolison, who has for some time past been serving with a wireless signal-company in the East African campaign, has written home a number of interesting communications, describing the conditions under which the campaign has been conducted, and the following notes are mainly extracted from his letters.

On the latest maps of the districts wherein the Anglo-Africander forces have been operating, the country is marked *unexplored* and—says our campaigner—"speaking "truly I should think no man would ever want to explore it. It is absolutely "nothing but thick bush, forbidding enough by day, and at night reverberating with "one perpetual roar of lions and hyenas. Last night a big brute dashed by the "electrician on duty, passing within a few yards of him, and broke three of the

CONSTANTZA, THE ROUMANIAN PORT RECENTLY OCCUPIED BY THE ENEMY FORCES, AND THE MODERN REPRESENTATIVE OF THE ROMAN TOWN OF TOMI.

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"*earths* connected with the station." Apart from the dangers incurred through the presence of these swarms of savage wild beasts, and apart from the heavy toil involved in cutting a way through thick and pathless vegetation, our wireless men have run constant risks through the manifold activities of the enemy. "During the course "of the most important fighting, the wireless station was shelled the whole day long "by one of the guns saved by the Germans from the wreck of the *Koenigsberg*." Fortunately, the range was not very accurately "spotted" by them, and practically no damage was done, although at times the telegraphists had some narrow escapes. Mr. Rolison instances one piece of shell, no less than 7 lb. in weight, which dropped in such unpleasantly close proximity to him that he is keeping this fragment as a souvenir of an almost miraculous escape.

At the time when the difficult task of clearing the country round Kilimanjaro and Meru was being conducted, the wireless section appears to have had an extremely hard three weeks' work. They rose to the occasion, and gave universal satisfaction by the way in which they accomplished their task, receiving in consequence official commendation for their strenuous exertions. Indeed our wireless friend records with easily comprehensible pride the fact that "The Headquarters "Staff complimented "us on several occa- "sions, and even stated "that the fate of the "column depended "upon us." Such a statement might appear at first sight to be a little far-fetched; but, when we come to look into the conditions of this campaigning we can understand the justification for it. The Anglo-Africander forces have found that the only possible lines of advance lie through the uncleared thick bush, cutting their way as they went, because all the *made* roads had been mined by the enemy, who had also

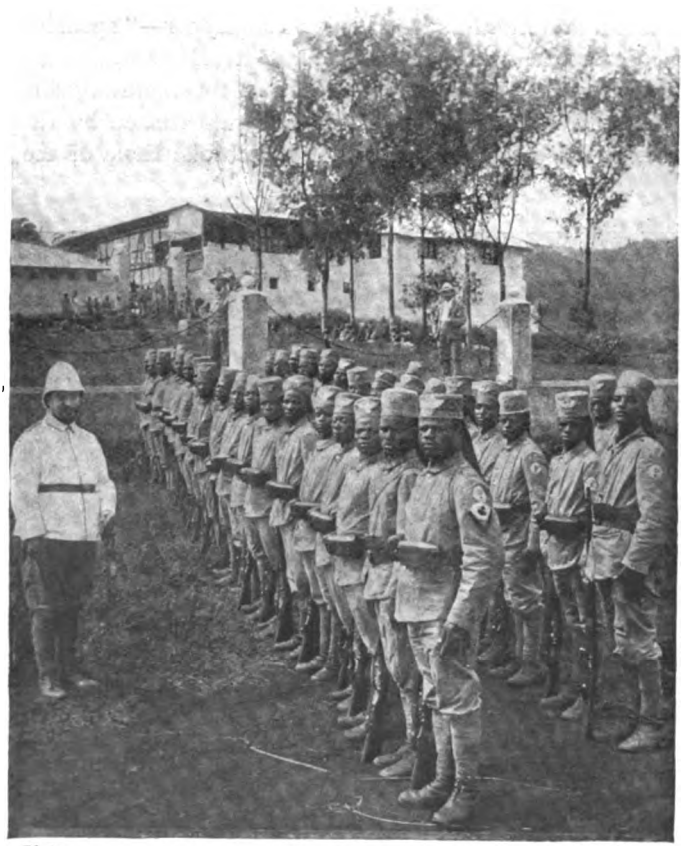

Photo [*Underwood.*

GERMAN "ASKARIS," THE NATIVE TROOPS WITH WHOM THE ANGLO-AFRICANDER FORCES UNDER GENERAL SMUTS HAVE HAD TO CONTEND.

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Photo by] [Photo Press.

ANGLO-AFRICANDER FORCES BIVOUACKING. THESE ARE THE WHITE TROOPS (WITH NATIVE BEARERS) WHO HAVE BEEN SO LONG CONTENDING WITH THE NATIVE ASKARIS UNDER GERMAN LEADERS. (*See opposite page.*)

completely demolished all the bridges. Think what this means! Picture to yourselves the small parties of axemen and others making a path where none was before, often separated from one another in such a way as to be completely out of touch save through intercourse by wireless, relying upon this medium not only for maintaining their communications with their brother-pioneers, but with the General in command. A prime necessity for forces operating in such districts is a regular supply of water, and it is the duty of those who discover such supplies to advise their Commanding officers without delay, for the enemy, reverting to the savage methods of Bushmen and American Indians, systematically tampered with all the known water supplies.

Our article in the November issue, under the title of "Wireless in Jungleland," explains some of the reasons why radiotelegraphy possesses such a marked superiority over wired telegraphy in these bush-infested tropical regions, so that it is hardly an exaggeration to take the view that wireless alone has enabled the Anglo-Africander advance to be made in many parts of German East Africa without the expenditure of an immensely larger force than has been available and without the consuming of a much longer period of time for the campaign.

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War Notes

THE recent occasion when a Norwegian Torpedo Boat Commander took drastic action against a German vessel, which attempted to ignore his orders, is typical of the sturdy spirit of his race. It will be remembered that, in defiance of Norwegian Wireless Regulations, the Teutonic Commander not only held on his course with aerials in full working order, but went so far as to ignore two warning shots fired across his bows. The Scandinavian Captain sent a boarding party and summarily dismantled the apparatus. The indomitable independence of the Norwegians has seldom been better exemplified than by their recent conduct under most difficult circumstances.

Indomitable Norway.

* * * * * *

We recently came across a rather amusing description of military aviators in Russia, and some of our readers may be interested to learn of the influence exerted by wireless telegraphy upon the fierce spirits of these Muscovite aviators. The pilots, we read, are real "Devils of the Air," whose lives are all of them "filled with unprecedented and terrible adventures." *They*, it will be noted, have nothing to do with wireless telegraphy; but the "scouts" are painted as men not only differing in *rôle*, but in character. Their business is to watch the effect and direction of the guns, report results, and give directions by wireless. Though apparently drawn from the same "raw material," they are described as "much calmer in temperament." As far as we can see, the only cause which can create this relative calm is that of a prolonged study of the applied science to which the world owes so much. So that, if we want to tame the wild and fiery spirit of an unruly young man, the suitable prescription appears to be—*teach him wireless.*

Wireless as a Tranquilising Influence.

* * * * * *

An interesting little point, in connection with the lies told by German wireless, came up recently when the Egyptian pilgrims to Mecca were returning to their homes. These annual pilgrimages, during which Mohammedans from all quarters of the globe meet together in common pursuance of their religious duties, constitute occasions when the various races compare notes with regard to what is going on in their respective countries. It must be remembered that these peoples, a large proportion of whom never learn to read, do not possess the universal sources of information available through the medium of the Press in Western lands. A prominent Egyptian Mohammedan recently stated that he and his fellow-Moslems were much impressed with the fact that at Jeddah, one of the historic seaports of Palestine, they saw with their own eyes a British man-of-war reported by the German wireless to have been sunk in the Battle of Jutland.

Ocular Demonstration.

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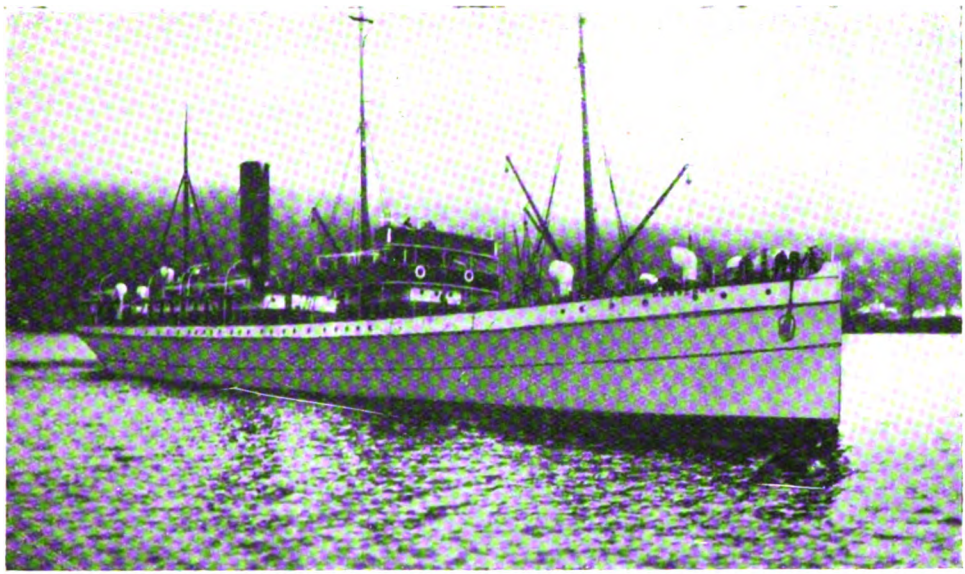

THE S.S. "MORWENNA"

From an Operator's Note Book

A Trip to Cuba

By DOUGLAS R. P. COATS

SHE was a trim little steamer, the *Morwenna* ; small, it is true, but comfortably found and when not butting into a heavy head sea as steady a packet as an eight hundred and fifty-six tonner could be. She introduced me to many things, including Cape Hatteras hurricanes and a German submarine,* and took me to places which but for her I might never have visited.

We had run down from St. John's, Newfoundland, and Halifax, and were lying at our wharf in Brooklyn when orders came for us to proceed to Havana. To me, as to all cigar-smokers, the name of the city was as familiar as Newcastle to an English coal merchant. It recalled the *Maine* incident with its tragic sequel, when someone was tactless enough to blow up an American warship at a time when Uncle Sam was in a scrapping mood. Somewhere, on fans probably, I had seen pictures of bull-rings in Havana, and somewhere else I had read of cock-fights. Señorita has certainly clapped her hands and flashed dusky, hero-worshipping eyes at these bloody encounters in the past, and may, for aught I know, do so to-day.

I was fired with a desire to investigate these matters and hoped to return with a story worth telling, but imagine my chagrin on our arrival at Havana when a string of code flags fluttering over the crumbling walls of Morro Castle told us to proceed immediately to Caibarien. It was most humiliating to be thus deprived

* See account of loss of s.s. *Morwenna* in Vol. III., p. 234

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of the pleasure of describing life in a city so bristling with romance as I believed Havana to be, but wireless orders confirmed and amplified the code flags' message, so there was nothing for it but to leave, finding what consolation we could in the thought that maybe the grapes were not so sweet after all, that written descriptions of the city might very possibly have been exaggerated.

To Caibarien, then, we went, and once again I must disappoint the reader who expects a picture of the town, for here the sea, generally such a rich indigo in West Indian regions, showed bottom through a light clear green, and shoaling far out from shore compelled us to anchor among some islands almost beyond sight of Caibarien itself.

The gentleman who boarded us for the purpose of examining the ship's papers was a Spaniard, attired in winter costume—a sort of flimsy pyjama suit and a black overcoat. We on the *Morwenna* were in white ducks and a state of perspiration at that, but this was winter in Cuba, and probably our visitor was cold, though I strongly suspect the overcoat was worn to create an impression, an effort in which the Spaniard was at any rate remarkably successful—if we did find it difficult to subdue our mirth! He spoke a smattering of English, all the time gesticulating with a pair of bony hands which Nature might have specially bestowed on a garrotter.

Mañana, we learned, was to see the arrival of our first sugar-laden schooners from Caibarien. Mañana means "to-morrow," a time said never to come, especially in these parts. The Cuban will start loading to-morrow; he will positively finish No. 1 hatch to-morrow; to-morrow he will do anything you please, but to-day—"Señor, it is impossible!"—and he flourishes those scraggy fingers of his. To-morrow came in this case, however, and brought with it three or four schooners high-piled with bags of sugar upon which reclined in various listless attitudes a number of the biggest niggers I have ever seen.

THE MORRO CASTLE, HAVANA

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The black man in these climes affects neither the airs nor the dress of his Europeanised brother of the north. The liberty, equality and fraternity idea does not appear to have penetrated so deeply beneath that thick skull of his, and mates can let themselves go with something of their old-time freedom of address to inferiors, though perhaps the white-toothed smile of the nigger may be accounted for by his poor understanding of vituperative English! He wears a two-piece suit comprising a pair of cotton unmentionables and an upper garment which is often a sugar-bag with holes cut for his head and arms. When working in the stifling atmosphere of the ship's hold he removes, not his coat, but the nether half of his wardrobe!

ABOVE: TOBACCO PLANTS IN THE FIELDS. BELOW: MAKING HAVANA CIGARS

Photos [Underwood & Underwood.

His labouring capacities are indeed wonderful. For hour after hour he will toil, staggering under giant bags of sugar, which he carries on his hip, his dark hide polished with perspiration and sugary stickiness. Sugar cane appears to be his staple diet, mealtime finding him squatting about the deck chewing assiduously at a three-foot piece of cane held flute fashion.

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To the obviously Spanish descended crowd who came out also on the schooners were assigned the less laborious tasks of checking cargo and running the winches. Hatred of work seems to be an instinct with the tan man in Cuba. He prefers, since he must do something, a job requiring the least possible exertion, one which will allow him to lean against some supporting wall or rail. He carries constantly a chocolate-coloured cigarette in his mouth and a small armoury in his belt. A brace of forty-five revolvers and a twelve-inch knife is not considered by him an excessive armament, the idea presumably being to command a certain respect which the decent stranger might otherwise be disinclined to give. I was not afforded an opportunity of witnessing his dexterity with the "shooting-iron," but if it approaches to his skill in handling a knife I imagine it to be pretty good.

Photo] [*Underwood & Underwood.*

ON A SUGAR PLANTATION, CUBA

We had been shark fishing with some success, inasmuch as a nine-foot bite lay dead upon our deck. Curiosity demanded an examination of the internal works of our catch, so the ship's cook was called upon to "open her up," an operation which he immediately attempted by jabbing at the white belly with his knife. The hide was tough, however, and repeated trials having failed to result in piercing it, one of our Spaniards smilingly took the knife from cookie and in a moment the shark's interior was open to view. It was wonderful, that lightning twist of the wrist, and I made a mental note always to be polite in my dealings with these amiable folk and to avoid any suicidal breach of etiquette.

Fishing in these regions is, to quote our American friends, a "cinch." If one wants muscular exercise, a game of tug-of-war and the excitement of dodging the gentleman's many rows of teeth, the accommodating shark is ready to oblige. The engine-room staff can manufacture the hook from half-inch iron rod; the deck department provides the line and a float consisting of one or two life-belt corks; while the cook hunts up a pound or so of meat. The bait is arranged to hang a couple of feet below the surface, the sharks flock round to make inquiries—you can

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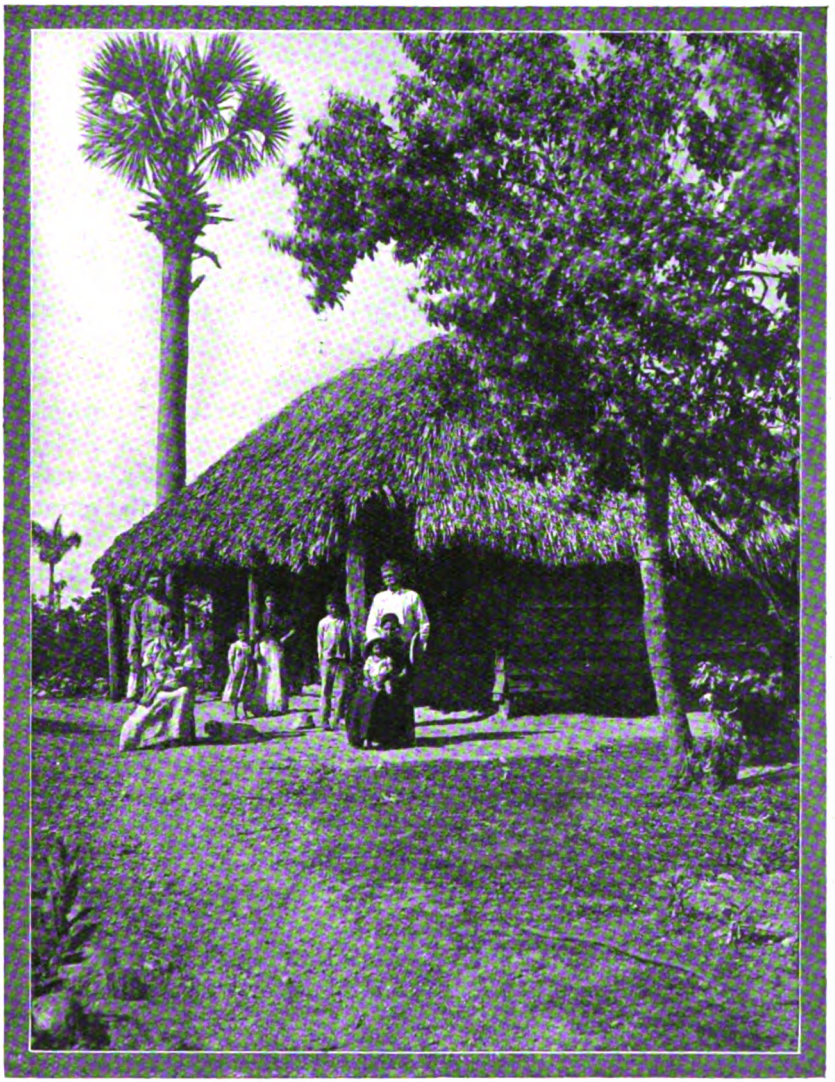

Photo] [*Underwood & Underwood,*

A FARM HOUSE IN THE PROVINCE OF PINAR DEL RIO, CUBA

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see their dorsal fins cutting the water—comes a snatch, a floundering and splashing, and then look out! He is away with bait, hook, float and all. If your line is mere signal halyard it parts when the big pull comes or frays on the keel as the shark dives under the ship and somewhere in the ocean there is a shark attached, in a manner which must be most interesting to his submarine acquaintances, to an iron hook, several pieces of cork, and twenty feet or more of line.

Heavier stuff will secure him, however, and when the monster is hauled partly out of the water a rifle-shot well placed will save all kinds of trouble in bringing him aboard. The specimen we caught was accommodating in more ways than one, for his stomach was a veritable museum of odds and ends thrown overboard during the week. It was amusing for a while to watch our stewards searching and to hear their exclamations as something fresh turned up, but the tropical sun soon made us anxious to be rid of Mr. Shark, and the work of removing his backbone for the purpose of making walking-sticks was hastened by the mate's instructions to "pitch the lavender over the side."

For those with weak hearts or jumpy nerves I can recommend catching pencil-fish. These are peculiar little fellows varying in size from a few inches in length to sometimes a foot and a half and have been given their name on account of their pencil-like noses. They reminded me of small swordfish with the serrated sword transformed to the perhaps mightier but certainly less dangerous "pencil." To the successful pencil-fisher four things are requisite—some strong thread, anything in the least resembling bait, a bent pin, and the faculty of being easily amused. The fourth is as necessary as the other three, for of all the dreary pastimes devised for keeping man out of mischief pencil-fishing is the tamest. The water is clear to the bottom and the fish are as thick as gold-fish in a small aquarium and about as easy to remove from their native element. The bait has only to be dropped by the creature's nose and held there long enough to be recognised as something to eat. The fish does the rest, and, provided he does not succeed in wriggling off the pin during the delicate process of hauling in, may be regarded as "caught" from the time he first notices the bait. His flesh is white and good eating, in spite of his innumerable hair-like bones, but the difficulty of picking him to pieces more than offsets the ease with which he is captured.

From Caibarien we proceeded, deeply loaded, to Philadelphia, and from thence the *Morwenna* returned to West Indian waters, this time to the much more interesting island of Hayti, or, as it is generally called to-day, San Domingo. I have far more to tell of our visit to the island of the unhappy black republic, but, as Kipling would say, "that is another story."

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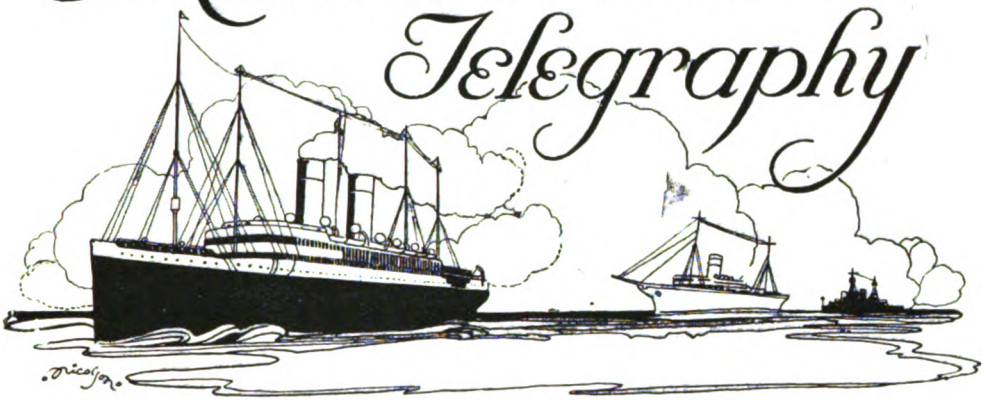
Maritime Wireless Telegraphy



Two "U" Boat Crimes.

There is no difference in the matter of principle between the two cases of German frightfulness which took place in the Mediterranean towards the end of November, when the *Britannic* and the *Braemar Castle* were both sent to the bottom. The sinking of the former, however, by virtue of her size, looms larger on our mental horizon. Originally designed for a White Star liner, it was the intention of her owners not only to fit her with a wireless installation of 5 kw. (plus ¼ kw. emergency), but also to equip two of her lifeboats with complete radio sets. As matters turned out, however, she only left the shipyard after the beginning of war, and never entered at all upon her intended career as a liner. With a tonnage of 47,500 gross, she was constructed in such a way as to exemplify the "latest word" in mercantile marine shipbuilding, and her destruction doubtless furnished a *bonne bouche* to our chivalrous foes. German wireless attempted to add insult to injury by a paragraph insinuating that the large number of the *Britannic* complement, which consisted of 1,200 souls, indicated that she was being used for purposes other than that of a hospital ship. This attempt was not only characteristically mean, but also absurdly inept, in view of the fact that the German boat *Imperator*, of approximately the same tonnage, used to carry a ship's company numbering 100 more than that of the *Britannic*.

The *Braemar Castle* was one of the oldest of the Union Castle steamers now afloat, and, in sharp contrast to the *Britannic*, could look back with pride upon a career of sixteen years' service as a liner in the South African trade. Her tonnage was 6,280 gross, and her wireless equipment consisted of the usual 1½ kw. set.

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A Gallant Attempt at Rescue.

Despite all that has been done to enable man to cope with the dangers involved in the navigation of the high seas, every now and again some dramatic incident brings home to us the fact that the forces of nature are as yet far from being within our control. A short while ago a message was received at Lloyd's from Falmouth to

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the effect that the Dutch steamer *Rijndam*, belonging to the Holland-Amerika line, reported that she had on a Sunday afternoon in November received the following SOS signal, in latitude 47 north, longitude 14 west, from the American four-masted ship *Manga Reva*: "Come as quickly as possible. Am drifting before the wind with no boats." The *Rijndam* answered the signal with "Coming full speed."

Not content with herself hastening to the rescue of the distressed American, the Dutch vessel sent a wireless message to the American steamer *Rockingham* (formerly the *Nebraskan*, and now owned by the Garland Steamship Corporation), asking her to proceed to the *Manga Reva*, as *she* was nearer to the locality of the distressed sailer than herself. The *Rockingham* accordingly steamed at full speed direct to the spot indicated, which she was timed to reach at 2 p.m. on the following Monday. However, despite these gallant attempts to go to the assistance of the crippled American sailing ship, the rescuers appear to have arrived too late, for the *Rijndam's* report to Lloyd's states that later on she received a message from the *Rockingham* announcing that she could find no trace of the *Manga Reva*, so that both Dutchman and American had no resource but to proceed each on her own course.

Here we have an occasion where Science has done her best, and where men have strained every nerve to deliver their fellow-creatures from the perils of the deep, but without success. But for every instance of such failure there are so many in which wireless has enabled the warnings to be effectual that such instances only serve to indicate that the risk of failure, though minimised, has not been altogether eliminated. Moreover, this incident in itself forms an admirable illustration of the way in which wireless at sea enables vessels to maintain touch, not only with the shore but with each other, in such a manner as enormously to decrease the chances that any ship may vanish from human ken and—as the greatest of dramatists puts it —"leave not a wrack behind."

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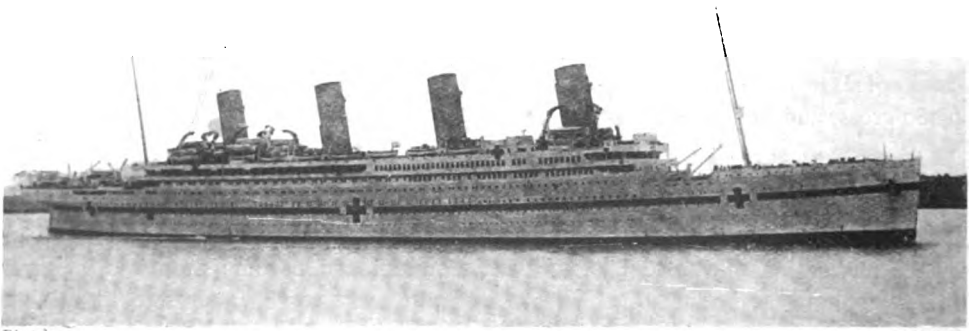
ADVENTURES "NEVER COME SINGLY."

The *Rijndam*, whose attempt to rescue an American ship we chronicle above, was more successful on another occasion. Two days out from St. John, answering



Photo] [Central News.

H.M.H.S. BRITANNIC.

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Photo] *[Exclusive News Agency.*

IN THE MARKET QUARTERS, SEMARANG.

a wireless SOS signal, she came across the *Vigilant*, a little American tug, belonging to New York and bound from Newfoundland to Cardiff. She proceeded to her assistance and took off the captain and twelve of the tug's crew. Three of the men refused to leave, and, taking control of the ship, actually succeeded in bringing her within sight of the Irish coast, where a British patrol vessel picked them up. The terrible weather encountered *en route* had smashed several parts of their little craft, and so tied them to their places that they remained for fifty hours without food, water or sleep. However, by sheer pluck they "won through." The *Rijndam* seems to tumble very rapidly out of one adventure into another, for, on her arrival at Las Palmas at the beginning of last December, she reported that she was a witness to the shelling and torpedoing of the Dutch cargo steamer *Kediri*, whilst she herself was being overhauled by another and somewhat smaller German submarine.

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An interesting little story has reached us in a letter from one of the Marconi operators on the Rotterdamsche Lloyd steamer *Wilis*. The incident occurred one day towards the close of September last when our correspondent's steamer was lying at anchor at Semarang, in Dutch Borneo. There were a number of other ships in the roadstead, amongst them, as a matter of course, several British vessels. The climate in this part of the world is warm, to say the least of it, so that on this September evening the wireless operator was glad to take his ease, book in hand as he reclined

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in a deck chair near the wireless cabin. The crew and stevedores were hard at work loading cargo, under the rays of a thousand-candle-power lamp, suspended near the bridge. Suddenly the eyes of the telegraphist were caught by light-signals, which were being flashed by the Morse lamp of a vessel not far away in persistent attempts to arrest the attention of the officer in charge of the *Wilis*. Our correspondent accounts for the fact that no one else had previously observed it by the fact that the mates were all extremely hard at work superintending the loading. On account of the strong electric "flare" suspended from the bridge it was not possible to utilise the *Wilis'* own Morse light. For a while he hesitated what to do, but at length was inspired with the brilliant idea of trying whether he could answer the call with his pocket electric lamp. Success crowned his efforts: by means of his "little portable apparatus" he managed to establish communication with the signaller on the British s.s. *Orestes*. "Wireless telegraphed me," says our Hollander friend, "that they were in urgent need of a doctor, one of the crew being in a state of collapse through sunstroke, whilst other members of the sea staff were ill." With this information the ingenious Dutchman went to the doctor of his own ship, and, as the latter expressed his willingness to undertake the duty himself, the "pocket wireless" was set to work once more, and announced the welcome intelligence to the *Orestes* that a boat would immediately put out in order to bring the much-needed medical assistance.

Our readers will, doubtless, have read descriptions of various forms of apparatus which claim to be pocket wireless sets, but we doubt whether any of them would have been capable of meeting the emergency detailed above by our correspondent. Scientific apparatus is useful; but far more useful still is alertness of mind and ingenuity in meeting a critical situation.

* * * * * *

GOOD RESCUE WORK ACCOMPLISHED.

Congratulations to the Union Castle Line. The days have long gone by since niggardly owners grudged the expense of delay involved by their vessels having stood by a sister in distress, and nothing better pleases the public-spirited shipowners of to-day than to find their captains able to record good rescue work accomplished. The Union Castle Line have in recent days strikingly maintained their excellent record in this respect. Our readers will perhaps remember that the 302 survivors of H.M. transport *Franconia* were rescued and taken to Malta by the *Dover Castle*, under the command of Captain J. N. Culverwell. A further rescue of victims of enemy submarine attack was recently effected by another vessel belonging to the same line—the *Glenart Castle*, commanded by Captain E. W. Day. The latter's rescue roll consisted of the captain, officers and crew of the torpedoed Newcastle steamer *Welsh Prince*, comprising 40 men in all. Both the South African liners were employed on Government service as hospital ships at the time when they came to the relief of the vessels in distress, and in each case wireless telegraphy played its usual honourable rôle of providing the medium through which the need of aid was communicated, and that by which the saving operations were rendered possible. Captain Day, of the *Glenart Castle*, appears to be quite specialising in such rescue work, for on two previous occasions he has received honourable recognition at the hands of the British and the Dutch Governments for saving shipwrecked crews under trying conditions during heavy weather at sea.

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Notes of the Month

Wireless Loyalty.

Various questions have recently been asked in the House of Commons concerning the loyalty of wireless operators on board British vessels, both mercantile and naval. With regard to the latter the answer is obvious: operators in the Navy are all necessarily British subjects. With regard to the former the greatest possible care has all along been taken, both by the Marconi Company, which supplies by far the greater proportion of such operators, and by the British Postmaster-General. It is not possible, in the national interests, to detail exactly what steps have been taken, but Britons, both at home and abroad, may rest assured that there is very little need for apprehension with regard to this matter of loyalty.

Wireless and the Occult.

People sometimes talk as though the study of science must necessarily involve a curtailing of the imagination and of the forces which act through it. Such is very far from being the case. Indeed, the more truly scientific we become the more do we exercise that side of the brain which is affected by what we may call the emotional influences of imagination. A short while ago we came across an account in our contemporary *Light*, a journal devoted to psychical, occult, and mystical research, wherein a young man who is now engaged on active service as wireless telegraphist at sea narrates how he came to take up the study. It appears that on the occasion of a séance he received a number of communications from the spiritual world through the medium of Mrs. Clara Irwin. Amongst the extraordinarily accurate descriptions then communicated there were certain items which affected his future career, and amongst these was a recommendation to take up radio-telegraphy. He followed the advice of his psychical mentor, pursued his studies with great success, gained his certificates, and is now actively pursuing his career. We wonder whether any of our wireless readers have been subjected to any similar "influence"!

Some Reflections of Sir Oliver Lodge.

The writings of the veteran scientist Sir Oliver Lodge are always well worthy of close perusal and thought, and we hope that Wireless World readers have not missed some contributions from his pen which have been recently appearing in our contemporary the *Daily Chronicle*. Sir Oliver has, *inter alia*, been pointing out the fact that wave undulation is far more generally common in nature than it is usually known to be by "the man in the street." After emphasising the wonderful way in which the everyday production of speech is brought about, through a series of "aerial pulsations," and recalling to his readers the wonderful way in which the hearing organs of the human body "tune out" the sounds that they do not wish to receive,

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whilst they " take in " and transmit to " auditory centres in the brain " the waves which they desire to take cognisance of, Sir Oliver lays it down that " wireless telegraphy " is not an iota more marvellous, but has, through its unfamiliarity, succeeded in arousing a sense of wonder.

We do not purpose attempting to give even the briefest résumé of this veteran scientist's papers, but the following sentence will indicate to our readers the general trend of his discourse. After pointing out that matter is an indirect medium of communication between one mind and another, he goes on to say: " That direct " telepathic intercourse should be able to occur between mind and mind, without " all that intermediate physical mechanism, is therefore not really surprising."

GERMAN CUT RATES FOR WIRELESS.

Information recently reached us through Geneva of a determined effort on the part of Germany to foster the interchange of wireless telegrams between themselves and America. The rate actually in force is 1 mark 50 per word; but in future each word is not to cost more than 35 pfennigs. This rebate of 115 pfennigs per word implies a reduction in charges amounting to over 76 per cent., and indicates not merely a desire to increase German propaganda news in the New World but also an attempt to cheapen communication and thereby stimulate trade between the two countries as soon as trade becomes possible.

A NEW WIRELESS SCHOOL.

We note with interest that at a recent meeting of the Newcastle Education Committee a recommendation was adopted for the establishment of a class for Wireless Telegraphy at Rutherford College. It was stated at the meeting that permission had been granted by the Postmaster-General and the proper authorities for the college to acquire and utilise the equipment. The Lord Mayor looks with great favour on the proposal and a small committee has been appointed, including that gentleman and five colleagues, to meet representatives of the shipowners on the Quayside with reference to the best way of carrying out the project.

AEROPLANES ACROSS THE ATLANTIC.

One of the effects of the present war has been to stimulate aviation to an extraordinary degree, and there is little doubt that as soon as peace supervenes the long-talked-of crossing from America to England by aeroplane will be accomplished. Indeed, it is openly alleged that there will be quite a race between rival experts as to who shall be the first to accomplish the feat. One of our Yorkshire contemporaries recently published an interview on the subject with the well-known aviator Mr. Rowland Ding, who is at present employed as a civilian test pilot of Government machines. He expressed the opinion that an important factor towards accomplishing the journey consists of the possibility of the newer aeroplanes being equipped with a complete wireless outfit, capable of keeping them in touch with transatlantic shipping as they proceed on their way. In this opinion he differs from the late Mons. Gustave Hamel, who looked forward to an occasion when he would be able to " rush " the journey on a light single-seated machine as bare of equipment as possible. Mr. Ding, on the contrary, prefers " a big, steady machine of enormous engine power " and dual control for two pilots."

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Operating in the Merchant Service

How to Join the Wireless Service of the Mercantile Marine

SOME eighteen months ago there appeared in these columns an article entitled "How to Become a Wireless Operator," in which we endeavoured to explain just what a young man had to do if he wished to take up this interesting profession. As the particular number of THE WIRELESS WORLD in which this article appeared is now out of print, and as the conditions since that time have somewhat altered, we have decided to set forth once more the salient facts which were previously given, modifying information where necessary and amplifying it where our experience has shown this to be required.

In two previous articles (October and November, 1916) we have explained fully how to join the wireless services of His Majesty's Forces, and we wish to make it clear at the outset that everything we say in this article applies solely to the wireless service on board ships flying the British flag. The conditions of service on board vessels of other nations differ considerably and cannot be stated in general terms.

The wireless telegraphic apparatus on board ship is under the sole control of the commander, and the shipping company to whom the vessel belongs, in the great majority of cases, hires the apparatus from the Marconi Company, who provide the necessary operator or operators. In such cases the Marconi Company pays the operator's salary and arranges with the shipping company to advance on account of salary a certain sum per week through the captain, in order that the operator may have enough money at all times to satisfy his immediate needs. The balance of salary is then drawn on arrival in port. The operator receives all his instructions of a technical nature from the Marconi Company, but he is, of course, required to carry out any orders which the commander or his authorised assistants may give him.

In some cases—very few in number—the shipping company employs its own operator, and in such cases conditions of service may differ from those we set forth here. It should be remembered, however, that an operator entering the service of a particular shipping company will not have much variety in his life, and will probably remain on one vessel or one ocean route for a very long time.

Assuming that our would-be operator wishes to enter the service of the Marconi Company, he must first see whether he can comply with that Company's requirements. All wireless telegraphists operating installations on board British ships must not only be British subjects, but both parents must also be British-born. For this reason a man, one of whose parents is of foreign birth (although naturalised in this country), is disqualified. All applicants must be of good character and must produce suitable references, either from previous employers, or, in the event of their never having been employed previously, from some responsible people who are personally well acquainted with them. Thorough physical fitness is also essential, and before

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acceptance every applicant is thoroughly examined by the Company's doctor, in order to discover whether he is constitutionally sound. It should be noted here that lameness, however slight, will bar an applicant from acceptance, although weak sight, if suitably corrected by glasses, will not necessarily act as a bar. It should be unnecessary to say that perfect hearing is absolutely essential.

With regard to the limitations of age, in normal times no man is accepted who is under 18 years of age or over 25. At the present time men slightly younger than 18 may be taken, provided they are otherwise suitable, but the limit of 25 is strictly adhered to. It is quite useless for a man who is over this age to commence training in the hope that an exception may be made in his case.

Before being appointed to a vessel, the applicant must obtain a certificate of proficiency granted after thorough examination by the Postmaster-General. This examination, of which full particulars are given in the *Handbook for Wireless Telegraph Operators Working Installations Licensed by His Majesty's Postmaster-General* (published by the Government and obtainable from the Wireless Press, Ltd., price 3d., post free 5d.) comprises tests in sending and receiving, knowledge of the theory of wireless telegraphy and knowledge of the practical working of the apparatus, including the tracing and clearing of faults. A course of training for the examination can be undertaken at one of the many wireless telegraph training colleges advertised in THE WIRELESS WORLD, and any of these institutions will be pleased to forward particulars regarding fees, etc., to readers who apply for them. There are also a number of correspondence courses which go a long way in teaching wireless telegraphy, but it should be clearly understood that no correspondence course can give complete training for the examination, as actual practical experience of a wireless installation is absolutely essential before the student is competent to enter.

Some of the schools running correspondence courses can arrange for a short time personal attendance at the school, so that the training can be completed.

Three classes of certificate are now granted by the Postmaster-General—*i.e.*, first class, second class, and temporary. In order to obtain the first class certificate the candidate must be able to send and receive accurately at least 20 words per minute for several minutes without error, and is required to show a thorough knowledge of the theory of wireless, the construction and manipulation of various instruments and the tracing and clearing of all faults which are likely to occur in actual work. He must also have a good knowledge of the regulations laid down by the Postmaster-General for the proper handling of wireless telegraph traffic and the general working between stations. To obtain a second class certificate just as much theoretical and practical knowledge is required, but the speed need not be higher than 12 words per minute. The temporary certificate, which has only come into existence recently and will probably be abolished when war is over and when the present abnormal demand for operators has subsided, requires a speed of at least 12 words per minute and some amount of technical and practical knowledge. It is always endorsed to show just what degree of knowledge is possessed by the candidate, and in this way the certificates vary to some extent. It should not be overlooked that no matter how clever an applicant may be in sending and receiving, in handling the apparatus and in acquaintance with the theory, he may quite conceivably fail to

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pass the Postmaster-General's examination through bad handwriting. It is not sufficient to be able to write clearly and legibly at a low speed; good plain handwriting at 20 words per minute is what the examiner looks for.

Having obtained the certificate, the newly-fledged operator should write to the Traffic Manager, Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C., stating his qualifications and asking for conditions of employment and form of application. On receiving these he should study them carefully and return the application form, together with the papers he is asked to provide. This will include his birth certificate and a signed, unmounted photograph. The birth certificate will be returned to him later, but the photograph will be retained.

Many applicants seem to imagine that the mere possession of a Postmaster-General's certificate entitles them by right to immediate employment by the Marconi Company. This is, of course, quite wrong. The Marconi Company can only offer employment to a man when it has a vacancy and when the man is found to be suitable for employment in its service. At the present time there is a very great demand for operators, and, providing the man is suitable, it is highly probable that he will be accepted immediately.

If, after perusal of the application papers, the Marconi Company decides to consider his application favourably, the budding operator will receive a letter inviting him to call at Marconi House for the purpose of receiving a test. Upon receiving such a letter the applicant should lose no time in proceeding to London, and, of course, the expenses in this connection will have to come out of his own pocket. For the benefit of those readers who are not quite sure of the location of Marconi House, we would mention that it is situated in the Strand, opposite Somerset House and about five minutes' walk from Charing Cross Station. Applicants arriving at Paddington should take the tube for Trafalgar Square, when a short walk will bring them to the office; those arriving at Euston should take the tube to the Strand; from King's Cross or St. Pancras, by Piccadilly tube to Aldwych (about one minute from Marconi House); from Marylebone by tube to Trafalgar Square; from Waterloo by bus to Wellington Street (half a minute from Marconi House); from Liverpool Street by bus to Somerset House; from London Bridge, buses 13, 13a or 13b to Somerset House; and from Victoria by District Railway to Temple.

On reaching the offices the applicant should state his business to the doorkeeper and will be taken by lift to the fifth floor, where he will be interviewed by a representative of the Traffic Manager at the first opportunity. Applicants who are required to wait some little time before being interviewed should not become impatient, but should remember that, especially with the war on, there is a great deal of much more important business than theirs to be attended to.

Provided the applicant is approved by the Traffic Manager, he will be required to proceed to the Company's doctor for medical examination, and, should he pass this test satisfactorily, he will be given a day on which to report for duty in the London school. The time he will be required to stay in the school depends upon his knowledge, and if he possesses a first-class certificate he will not remain there long. Some men who possess a first-class certificate are surprised that they are required to attend even a few days at school, but it must be remembered that the P.M.G. certificate is

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not a certificate for proficiency in the *Marconi Company's methods*, but only in general radiotelegraphy. On appointment to the staff a Marconi operator commences with a salary of £1 a week, and, of course, whilst he is on board ship he receives his board and lodging free. If he should be appointed in charge of a ship's installation when his salary is under 30s. a week he will be given an additional 5s. per week so long as he is in charge of the installation. Provided the operator's conduct is satisfactory, annual increases of pay of 2s. 6d. per week are given, until 30s. per week is reached, after which annual increases are given at the rate of 5s. per week up to a maximum of £2 15s.

In the event of the operator being employed on shore for a considerable period an additional allowance will be made to cover the additional living expenses, and if he should be appointed to any special duties additional remuneration may also be given.

With regard to uniform, with which the operators are required to furnish themselves, there are a number of tailors advertising in this magazine who specialise in Marconi uniforms and will be able to advise the new operator exactly what he requires. It is always advisable to go to a tailor who has experience in making Marconi uniforms, otherwise the operator may be gravely misled. He will be perfectly safe in dealing with any of the firms whose advertisements he finds in this magazine.

We are frequently asked whether it is not possible to join the Marconi Company's London School without having obtained one of the Postmaster-General's Certificates. To this the answer is: the Marconi Company from time to time is in a position to take suitable young men who are keen to become wireless operators and place them in the London School for full training. Applications should be addressed to the Traffic Manager, Marconi International Marine Communication Co. Ld., Marconi House, Strand, W.C. Such men are given a thorough training for the Postmaster-General's Certificate and will be required to pass the examination within a reasonable period. No fee is charged for such instruction—on the contrary, if the man's conduct and general progress are satisfactory, he will be paid a small salary after he has made some progress, and this may be increased towards the end of the course, provided his advancement continues to be good. Students who come into the school with a good knowledge of telegraphy will naturally be paid at a higher rate than those who enter with no knowledge whatever.

Before accepting any position which the Marconi Company may offer, the applicant should carefully peruse the conditions of service. He should understand, for example, that he will be required to take duty on any ship sailing to any part of the world, and that he must be prepared to take the rough with the smooth, serving either on a cargo vessel or liner as the Company may require. The progress he makes in the Company will depend entirely upon his own ability, and, other things being equal, the best men will be appointed to the best ships. Lastly, he should not forget that the "Questions and Answers" column of this magazine is always open to him for the solution of any difficulties which may arise in his consideration of the new career.

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Interned in Germany

British Wireless Operators at Ruhleben

MANY of our readers will be interested in the photogragh below, which shows two of the Marconi Company's operators, Messrs. B. O. Baxter and R. J. Henry, who have been interned since the outbreak of war at the Ruhleben Camp. Mr. Baxter was the operator on the s.s *San Wilfredo* and Mr. Henry on the s.s *Nicoya*. Both of these vessels were in the Elbe on the outbreak of hostilities, the *San Wilfredo* being sunk by a mine. We understand that the crews of both these ships are all at Ruhleben.

Conjecture has been rife amongst the various associations which have for so long contributed towards the comfort of our interned prisoners as to their position owing to the establishment of the new Central Prisoners of War Committee, which has been recently formed for the purpose of ensuring that all British prisoners of war in enemy

A PHOTOGRAPH TAKEN IN THE INTERNMENT CAMP AT RUHLEBEN. ON THE LEFT, STANDING, OPERATOR B. O. BAXTER. ON THE RIGHT, STANDING, OPERATOR R. J. HENRY.

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countries shall receive an adequate supply of foodstuffs and to prevent all possibility of overlapping in the future.

The Mercantile Marine Service Association, in particular, which has for so long been despatching food, clothing and tobacco to the British merchant seamen of all ranks interned in Germany, Austria, Turkey, was much concerned by the new arrangements. An impression seemed to exist amongst the general public that this new Committee was being financed by the Government and would include all ranks and all classes of men.

The Secretary of the Mercantile Marine Service Association accordingly approached the Central Prisoners of War Committee making inquiries as to its scope, and a reply has now been received in which statements are made to the following effect: (*a*) The Central Prisoners of War Committee is in no way financed by the Government, being entirely dependent for the success of its work on the generosity of associations and individuals; (*b*) officers of the Mercantile Marine (viz., masters, mates, including chief officers, engineer officers, pursers, doctors, wireless operators and apprentices, skippers and second hands of fishing vessels) are all exempt under the new regulations. In view of these facts, the Committee express the hope that public bodies would still continue their kind contributions towards the support of the merchant service prisoners of war. In these circumstances the Council of the Mercantile Marine Service Association, with the generous support of its many friends, is continuing its efforts to ease the sad lot of our merchant seamen who have the misfortune to be in the enemy's hands.

Correspondence

We hasten to print the following letter which has just come to hand, and fully apologise to all those Australian readers whom we may have unwittingly offended!—EDITOR.

DEAR SIR,—All the 700,001 inhabitants who dwell near the sides of the "Beautiful Harbour of Sydney" are after you with the selfsame inhabitants' family carving knife and hatchet thirsting for your blood.

By an error, no doubt, you have mortally offended all Sydneyites, who are inordinately proud of their harbour, "a jewel to which no other can compare."

On page 383 of the present volume you show a view purporting to be "A General View of the Beautiful Harbour of Sydney," which in reality is one of Devonport, Northern Tasmania. As you state in letterpress, one of the two first Marconi stations in Australasia was at Devonport, and the view, the credit of which you would give to Sydney, is one of this pretty Tasmanian watering-place and the River Mersey, taken about 1½ miles south of the wireless station.

I might add the station has long since been dismantled.

On your future visits to Australia, Mr. Editor, you are advised to avoid Sydney, but you may be sure of a warm welcome from Devonians who appreciate the Tasmanian coastal town.

Best wishes,

"PMACS."

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Amateur Mechanics Wanted for the Royal Engineers

WE have pleasure in directing our readers' attention to the following letter :—

DEAR SIR,—A number of the amateurs who have been enlisted at this depot have turned out to be very suitable men, and it has occurred to me that perhaps you would let it be known, through the medium of your paper, that there are further vacancies in this centre.

At the moment we are particularly in need of men who possess some skill in working ebonite and brass, as instrument makers.

I attach particulars of the conditions of service, and should be pleased to give you any further particulars you may require.

Yours faithfully,
A. HANDLEY (Major R.E.)
O.C. Wireless Training Centre, R.E.

Wireless Training Centre,
Royal Engineers,
St. Martin's Gate, Worcester.

Vacancies exist in the Wireless Section, Corps of Royal Engineers, for the following tradesmen :—

Electricians,
Instrument repairers,
Engine drivers,
Fitters,
Wireless operators.

QUALIFICATIONS.

The following qualifications are necessary for enlistment :—

ELECTRICIANS.

Essential.—Thorough knowledge of ordinary electrical work (including dynamos, motors, accumulators and telephones, bells and electric lighting). Thorough knowledge of all soldering work.

Desirable.—Knowledge of internal wiring of transformers, dynamos and motors ; ability to re-wind and repair same ; ability to use lathe (trueing up commutators, etc.) ; knowledge of wireless ; knowledge of bell and telephone wiring, switchboard experience.

INSTRUMENT REPAIRERS.

Essential.—Ability to use treadle lathe and do plain turning ; experience in small scientific instruments (making and repairing) ; knowledge of use of taps and dies, and soldering.

Desirable.—Knowledge of electricity ; knowledge of wireless ; knowledge of telephone repairing, and ability to wind small coils, etc. ; ability to do screw-cutting on lathe. (Watchmakers generally of little use.) Also knowledge of milling.

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ENGINE DRIVERS.

Essential.—Able to drive small internal combustion engines and do ordinary repairs. Able to ride twin motor cycles up to 8 h.-p. and carry out repairs.

Desirable.—Able to drive heavy lorries or cars up to 30 h.-p. and carry out ordinary repairs ; knowledge of draughtsman's work.

FITTERS.

Essential.—Knowledge and experience of small or motor cycle internal combustion engines up to 8 h.-p. ; able to do all repairs to above ; knowledge of ordinary fitter's work and soldering.

Desirable.—Knowledge of turning and screw-cutting ; knowledge and experience of heavy car and lorry engines up to 30 h.-p. ; knowledge of electricity, also brazing and welding ; able to drive car or lorry.

WIRELESS OPERATORS.

Essential.—Ability to send and receive at not less than twenty words a minute on sounder or buzzer.

Desirable.—Knowledge of wireless telegraphy.

TERMS OF SERVICE.

Men are enlisted for the duration of the War.

Electricians, instrument repairers, engine drivers and fitters enlist as Sappers ; wireless operators as Pioneers. If found suitable at the conclusion of training in the Signal School, Pioneer Operators are re-mustered Sappers.

Recruits are given a course of training in the workshops and Signal School of the Wireless Training Centre and on completion of this course are drafted to the Expeditionary Forces.

PROMOTION.

Prospects of promotion to N.C.O. rank are good for men of high technical qualifications possessing ability to command men.

Vacancies arise at intervals for military mechanist staff-sergeants, and men from the ranks having special knowledge and experience of technical apparatus are chosen to fill these positions.

Frequently openings occur in the commissioned ranks for the Royal Engineers. Since the formation of the Wireless Training Centre eighteen commissions have been taken up by N.C.O.'s and Sappers, while at the present time a good number of Cadets chosen from the ranks are undergoing a course preparatory to taking up commissions.

PAY.

The following are the rates of pay in the Wireless Section R.E. :—

Rank.	*Regimental Pay.*	*Engineer Pay.*
Pioneer	1s. 2d. day ..	.. .. 6d. day.
Sapper	1s. 2d. ,, ..	1s., 1s. 4d., 1s. 8d., or 2s. day. (according to qualifications).
Lance-Corporal	1s. 6d. ,, ..	,,
2nd-Corporal	2s. 2d. ,, ..	,,
Corporal	2s. 6d. ,, ..	,,
Sergeant	3s. 3d. ,, ..	,,

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Military Mechanist Staff-Sergeant: Consolidated pay at the rate of 5s. 3d. a day.

The usual Separation and Dependants' Allowances are given in addition to the above.

For the first twenty-eight days only, during which the recruit is undergoing a course in squad and manual drill, use of arms, musketry, etc., Engineer pay is reduced by 6d. a day.

APPLICATIONS FOR ENLISTMENT.

Applicants for enlistment should apply at least a fortnight before they become liable for military service.

This will allow sufficient time to enable War Office approval or otherwise to be given for special enlistment in a technical unit.

Applications should contain full particulars as to qualifications, and, if possible, medical classification.

Merchant Service Uniform

The several organisations of shipmasters and officers, ably seconded by that of the marine engineers, which exist for the purpose of safeguarding the interests of the certificated members of the merchant service, have lately been actively pressing for a distinctive uniform for the mercantile marine. Our seamen have done excellent work for the country during the present war and they desire, and ought to have, a suitable and distinctive uniform, established and recognised by the Government, defined by rules and regulations which would entirely abolish the present haphazard system whereby fourth officers of one steamship line wear the same uniform as the masters of another.

On Monday, November 6th, a conference upon this subject took place at the Admiralty between representatives of the various shipmasters' and officers' societies and the officials of the Department, headed by Commodore Cecil F. Lambert, R.N., Fourth Sea Lord, the object being to place the Admiralty in possession of the views of the officers of the mercantile marine on the question.

On Tuesday last an important and very influential deputation was received by Mr. C. Hipwood, Assistant Secretary to the Marine Department of the Board of Trade, with a view to a further consideration of the proposals. Mr. Basil Peto, M.P. introduced the deputation.

Amongst those present were Commander A. Houghton, R.N.R. (President), and Captain J. R. Coverley (Member of the Executive Council), of the Mercantile Marine Service Association, Captain J. W. Grace (Chairman), Captain A. B. Toms (Vice-Chairman) and Lieutenant T. W. Moore (Secretary), of the Imperial Merchant Service Guild, and Mr. Todd (President) and Mr. D. Bramah (Secretary), of the Marine Engineers' Association. The various members of the deputation all expressed their own views and were accorded a most courteous and patient hearing from Mr. Hipwood. No definite decision was arrived at, but the members of the deputation express themselves well pleased with their reception and the evident desire of the Board of Trade to meet, as far as possible, the views of the masters and officers of the mercantile marine.

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The Calculation of the Inductance of Single-Layer Air-Core Solenoids

By PHILIP R. COURSEY, B.Sc. (Eng.).

As Lieut. Hoyle has pointed out in his articles dealing with this subject, there are a large number of formulæ available for the calculation of the inductance of air-core solenoids, each applicable to a different shape or type of coil, so that some confusion may often arise as to the best formula to employ in any particular instance. More especially is this the case when one is using them at somewhat infrequent intervals for the calculation of odd coils, and much valuable time may in consequence be lost through an incorrect choice. Moreover, many of the formulæ are very complicated, and consequently rather unsuited for practical work. Any simplification or limitation of the available formulæ is therefore always welcome, as conducive to greater speed and accuracy in calculating results. Lieut. Hoyle's article should be useful in this respect.

If a word of friendly criticism will not be taken amiss, it may be pointed out that a little confusion might possibly have been avoided had *both* the Tables of Q and of X in his article been given for values of $2a/b$ (=diameter/length), *or* of a/b (=radius/length), instead of one table with each function. There would then be less liability of errors arising through failing to notice this difference when passing from one table to the other.

It may be as well also to point out that in the great majority of the cases that occur amongst the coils used for wireless apparatus it is quite unnecessary to evaluate the correction ΔL for the insulation and number of turns on the coil, since in practically every case its value is less than 1 per cent. of the actual inductance of the coil, and only in very extreme cases does it reach about 2 per cent. of that value. The correction might be worth considering were it possible to predetermine the inductance of a "wireless" coil with such accuracy, but in general practice it is neither necessary nor even possible to do so. The reason is to be found in the fact that the inductances as calculated by these formulæ (even when the above correction is included) are still low frequency values, whereas the coils are to be used for high-frequency currents. The change from low to high frequency brings about a change in the effective inductance of the coil—generally in the direction of a decrease of the inductance—which, although not very large, is yet usually sufficient to mask any such corrections as the above and to render them rather unnecessary. The result is also modified by such phenomena as the "self-capacity" of the coil, a quantity which is of great importance at high frequencies. Further, it is a very rare occurrence that a circuit has to be made up to possess a certain natural oscillation frequency or wave-length without means being provided for the adjustment either of the capacity or of the inductance of the circuit. In these circumstances, therefore, it is not necessary to calculate (or measure) the inductance to a very high degree of accuracy, and in the vast majority of cases met with in general experimental work a 5 per cent. accuracy is ample. Hence it is usually unnecessary to work out the values to a

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"four figure accuracy," and a slide rule will generally yield all the results that are required.

When this is the case it is possible to simplify matters still further than has been done by Lieut. Hoyle by the use of only one formula for any of the cases that are likely to arise. The formula referred to was first given by Prof. Nagaoka * and may be written in either of the following forms :—

$$L = \pi^2 D^2 n^2 l k \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

or,
$$L = \frac{W^2}{l} k \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where, L = Inductance of coil in centimetres.

D = Mean diameter of coil (to centre line of turns) in centimetres.

l = Length of coil in centimetres.

n = Number of turns per centimetre length of coil $= N/l$, where

N = Total number of turns on the coil,

k = A "correction factor" which is a function of the dimension ratio l/D of the coil.

W = Total length of wire on the coil, in centimetres.

(NOTE.—It is evident that $W^2 = (\pi D)^2 \times N^2 = (\pi D)^2 \times (nl)^2$, so that the two forms are really equivalent to one another.)

Values for k are tabulated in the *Bulletin of the Bureau of Standards*, Washington, Vol. 8, page 224 (1912). The figures there given do not, however, meet quite all the cases of coils used for wireless work, so that the writer has calculated some further values to meet these cases. These were published in the form of curves in the *Electrician* for September 10th, 1915, Vol. 75, page 841. By the use of these curves of k, the inductance of any given coil may be quickly determined, especially if a slide rule is employed, without any chance of confusion in selecting a formula. The curves may be used for any shape of coil, from a single turn upwards ; and also for "flat" (or "pancake") coils, as well as for solenoids, if it is remembered that the inductance of a flat coil of mean diameter $= D$, and radial depth $= l$, is to a first approximation the same as that of an ordinary solenoid coil of the same mean diameter, and of axial length $= l$. In the paper above referred to additional curves are also given to facilitate the design of a coil to have any given inductance, by a further application of the same general formula.

As a comparison of the two methods, the inductances of the coils taken as examples in Lieut. Hoyle's article are worked out below, using the above formula and curves :—

(1) The first example, for which $D = 50$ cms., $l = 1$ cm., and $n = 10$ turns, we have $l/D = 1/50 = 0{\cdot}02$, and from the curves the corresponding value of $k = 0{\cdot}061$.

Therefore we have

$$L = \pi^2 \times 50^2 \times 10^2 \times 1 \times 0{\cdot}061$$
$$= 150{,}000 \text{ cms.}$$

The value given by Lieut. Hoyle is $47385\pi = 148{,}800$ cms.

The difference $= 1{,}200$ cms. $= 0{\cdot}806$ per cent.

* *Journal* College Science, Tokyo, Vol. xxvii, 1909.

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(2) In his second example,

$$D=25 \text{ cms.}, \; l=10 \text{ cms.}, \; N=100,$$
$$\therefore \; n=N/l=10,$$
$$\text{and } l/D=10/25=0{\cdot}40,$$
$$\therefore \; k \text{ (from curve)}=0{\cdot}471,$$
$$\text{Therefore } L=\pi^2\times 25^2\times 10^2\times 10\times 0{\cdot}471.$$
$$=2{,}905{,}000 \text{ cms.}$$

The value given by Lieut. Hoyle is 2,902,000 cms.

The difference = 3,000 cms. = 0·103 per cent.

Both the above were worked out by the help of a slide rule and give results differing by less than 1 per cent. from his calculated value, so that from the practical point of view there is little to choose between the two methods on the score of accuracy, while the use of a single formula for any and every form of practical (single layer) coil should be a distinct advantage in all ordinary work.

The "Naval Bairnsfather"

READERS of THE WIRELESS WORLD are familiar with the name of Beuttler. It figures upon a number of cartoons, which appeared month after month in our earlier volumes, and which only the exigencies of war-conditions compelled us to discontinue. The same deft hand is still frequently to be found in our pages, and the "Sparkington-Gapp" series owes a great deal to the artistic humour of Lieut. Beuttler's illustrations.

LIEUT. E. G. O. BEUTTLER, R.N.V.R.

Under the title of the "Merry Mariners" a series of the gallant seaman's drawings have recently appeared in book form (*United Newspapers, Ltd., price* 1s.). We can conscientiously recommend every reader of THE WIRELESS WORLD to purchase a copy; one does not have the chance every day of securing so good an investment for the "nimble shilling." One of the best drawings, in the series under review, represents a British aeroplane fishing for "U" boats. They have tried all sorts of bait without success, but finally bring the German shark to the surface by the lure of a dummy baby. The thirst for destruction of the weak

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and helpless displayed by these literal "Enemies of the Human Race" is admirably indicated. It can be felt in the spirit of the drawing. This cartoon fulfils a fundamental canon of the Art; that, to wit, which demands a seriously satirical side to the humour. The Dutchman, M. Louis Raemaekers, possesses this quality in an eminent degree, and largely owes to it his superlative position.

We are glad to notice, in the little collection of drawings before us, fresh indications of that improvement in technique which also forms a marked feature of the Beuttler sketches that have appeared in our recent numbers. Moreover, the artist is to be congratulated on having largely given up the overcrowding of his pictures with figures, a tendency which detracted from the artistic value of his earlier work. In order to point our remark we print on this page (by kind permission of Lieutenant Beuttler and the *Daily Chronicle*) a reproduction in miniature of one of the cartoons where the figures are but two in number, a restriction which adds considerably to the strength of the effect. Feeling, moreover, that our readers will be interested to see the lineaments of one who has contributed so much to their amusement we here present them with his portrait, for which again we are indebted to the courtesy of our daily contemporary.

CURATE: "MY MAN, HOW YOU MUST *love* THE SEA!"

BLUE-JACKET: "BEGGIN' PARDON, YOUR REVERENCE; FISHES WERE MADE FOR THE SEA AND HUMANS FOR THE BEACH. NOW, DO I LOOK LIKE A HADDOCK?"

(From "Merry Mariners," by Lieut. E. G. O. Beuttler, R.N.V.R.).

In our December issue we published—as one of our "Pastimes for Operators" series—an article on sketching. We believe that the hints there given by our contributor will be found inspiring by many young operators, and we should like to add the further recommendation that any aspirants after artistic attainments should study the work of those who have already made their mark; not in order to imitate them, but in order to learn the secret of their success. Amongst such subjects for artistic study we would include the drawings of Lieut. E. G. O. Beuttler, R.N.V.R.

One of the hall-marks of success, which is generally looked upon in the artistic world as a mark of "one who has arrived," is the acceptance and publication of a drawing in the pages of *Punch*. Our readers are doubtless aware of the fact that, on more than one occasion, specimens of our old friend's artistic work have appeared in the pages of the *London Charivari*.

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Among the Operators

OPERATOR F. N. CALVER.

THE HOSPITAL SHIP "BRITANNIC."

THE terrible outrage on the hospital ship *Britannic* is referred to on another page. This vessel carried two operators, F. N. Calver, sen., and S. E. Cleverley, jun.

Frank Norman Calver was born at Balham in November, 1891, and received his education at that place. He trained for wireless telegraphy and received his P.M.G. Certificate at the British School of Telegraphy, Clapham Road, and joined the Marconi Company's London School in April, 1912. Before joining the *Britannic* he had served on a number of large vessels, including the *Aquitania*, *Mauretania*, and *Caronia*. We are very pleased to be able to announce that Mr. Calver was among those saved from the wreck, being rescued without injury.

OPERATOR S. E. CLEVERLEY.

The junior operator, Mr. Stephen Ernest Cleverley, who was also saved, uninjured, is a native of Devonshire, and is but a few months younger than Mr. Calver. He was educated at Plymouth and received his preliminary wireless training at the school of Mr. Jerritt, of Bedford Park, Plymouth. Joining the London School in February, 1913, he soon completed his training, and served on the s.s. *Pardo*, *Amazon* (several trips), *Canning*, *Anglo-Saxon*, *Reventazan*, and *Canada* before being appointed to the *Britannic*. We heartily congratulate both these men on their fortunate escape.

OPERATOR THOMAS RHODES.

* * * * *

ANOTHER HOSPITAL SHIP.

The *Braemar Castle*, another hospital ship which has fallen a victim to Germany's

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OPERATOR A. POWER.

methods of warfare, carried as operators Messrs. Thomas Rhodes and Arnold Power. Mr. Rhodes, who hails from Hull, is 24 years old, and was educated at Leeds. He received his preliminary wireless training at the British School of Telegraphy, and joined the Marconi House School in May, 1912, and shortly afterwards was appointed to the s.s. *Tunisian*. He afterwards served on the s.s. *Royal George*, *Minneapolis*, and a number of other ships, receiving his appointment to the *Braemar Castle* two years ago. We are glad to say that Mr. Rhodes is reported as safe and sound.

The junior operator, Mr. Arnold Power, is of Irish birth, his home being in Kilkenny. On leaving school he became interested in wireless telegraphy, and took a course of training at the Atlantic Wireless College, Caherciveen, where he received his first-class certificate. He joined the Marconi Company as recently as September last, the *Braemar Castle* being his first ship. Mr. Power was also rescued uninjured, and is, we believe, none the worse for his experience.

* * * * * *

S.S. "CITY OF BIRMINGHAM."

The *City of Birmingham*, which was recently sunk, carried one operator, Mr. Bernard Hamilton Montgomery, of Sheffield. Mr. Montgomery, who is 29 years of age, was employed as a telegraphist in the Post Office before joining the Marconi Company. He joined the London School in February, 1911, and has served on a large number of vessels. We are glad to say that he was saved from the wreck and is uninjured.

* * * * *

S.S. "RAPPAHANNOCK."

The loss of this ship and all her crew has already been reported in the daily Press. The wireless operator, Mr. William Jasper Jane, whose sad death we must here chronicle, was a native of Plymouth, and 22 years of age. He was educated at Plymouth Public School and the grammar school in that town, and on leaving entered a business career, and later joined the National Telephone Company, Taking an interest in wireless telegraphy, he received a preliminary training at Mr. Jerritt's school,

OPERATOR B. H. MONTGOMERY.

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THE LATE OPERATOR W. J. JANE.

joining the Marconi House School in March, 1915. On the completion of his training he was appointed to the s.s. *Mennon*, later transferring to the s.s. *Bornu*, and thence to the *Cambrian*. He had already sailed for two trips on the s.s. *Rappahannock* before she was sunk. Deep sympathy is felt with the late operator's parents in their bereavement.

* * * * *

OPERATOR T. MOYLAN.

We regret to announce the death in Canada of Operator Thomas Moylan, who was 23 years of age, was born at Liverpool, and educated at Seaforth. After leaving school he obtained a position in the telegraph department of the *Liverpool Daily Post*, and joined the London School in November, 1915. On appointment to the staff he took duty on the s.s. *Theseus*, but he had not long been on this vessel when he was removed to hospital in Montreal. Very deep sympathy is felt for the late Mr. Moylan's mother, as his father died a short time ago, and we believe a brother was killed earlier in the year.

THE LATE OPERATOR MOYLAN.

* * * * *

LONG DISTANCE BY AMERICAN OPERATOR.

Operator A. J. Costigan, of the s.s. *Floridian*, has reported a new long-distance record.

The *Floridian* left San Francisco for Sydney, Australia, on July 12th; from that date, up to and including July 31st, the vessel's position was transmitted to San Francisco. With a single exception, these position reports were received directly at the Marconi Hillcrest Station, near San Francisco, up to a distance of 5,227 miles.

The *Floridian* is equipped with the standard Marconi 2 k.w. 500 cycle panel set. The current consumption at the transformer did not exceed 1,600 watts up to 2,600 miles, and at 5,200 miles the power consumed was 2,600 watts. Costigan says the San Francisco signals were audible up to some 3,000 miles.

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An important patent suit is being litigated this month in the United States District Court, where his Honour Judge Mayer, you will recall, recently handed down a decision in the Fleming Valve case, and before whom was also tried the National Electric Signalling Company's high-frequency patent suit. The present contest is between the Atlantic Communication Co. (Telefunken System), defendant, and the National Electric Signalling Co., plaintiff. Patents involved are those covering continuous wave transmission and Heteroddne system of reception, Fessenden claiming invention of both methods. Prominent among those engaged in this suit are Professor Zenneck and Mr. John Stone, Stone for the Atlantic Communication Co., and Mr. John L. Hogan, jun., who is testifying as expert for the National Electric Signalling Co. While the case is only about half finished at this time, there have already been on the stand Mr. Nikola Tesla, Professor Pupin, Mr. Alexanderson, the designer of the General Electric high-frequency alternator, and other prominent personalities in the radio world.

The United States Senate recently passed a resolution providing for the investigation of matters relating to Interstate Commerce, as well as the advisability of Government ownership of telephone, telegraph, and wireless communication systems. The committee consists of the following gentlemen, and is known as the Newlands Committee :

Senator Newlands, Nevada (Chairman).
Senator Underwood, Alabama.
Senator Robinson, Arkansas (Secretary).
Senator Brandegee, Connecticut.
Senator Cummins, Iowa.
Senator Cullop, Indiana.
Representative Adamson, Georgia (Vice-Chairman).
Representative Simms, Tennessee.
Representative Esch, Wisconsin.
Representative Hamilton, Michigan.

This Committee is empowered to make an exhaustive investigation of the subjects mentioned, and also to call such witnesses from the various industries as in

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the Committee's opinion may be necessary. I have just learned that the Joint Committee will begin its investigation of the radio subject on November 20th, 1916, in the Senate Office Building at Washington, D.C. In this connection I should mention that certain people in Washington, and in particular some of the executive and administrative officers now connected with the Government branch of radio communication, hold the opinion that existing commercial radio coast stations in the United States should be taken over and operated by the Government. To this end a bill is being drafted, and I understand it is proposed to introduce this bill at the next session of Congress. The exact provisions of this bill are not yet definitely known. In commercial as well as in scientific circles I have heard nothing but strenuous opposition to such a move, and it is expected that before any bill of this character is presented to Congress commercial and other interests will be given an opportunity to present their side of the case. The importance of this vital subject accounts for the great interest expressed by all those actively connected with the art of radio communication.

A novel experiment is to be tried with amateur radio equipments during the coming Presidential election. Members of the National Amateur Wireless Association are to take the lead in a nation-wide preparedness test. Under the leadership of W. H. Kirwan (9XE), of Rock Island, Ill., who has been appointed National Chief of Relay Communications of the N.A.W.A., the amateurs will be organised into a relay chain to broadcast throughout the country messages from President Wilson. The great organisation of licensed amateur stations under N.A.W.A. control will be placed at the disposal of the National Chief of Relay Communications, and selections will be made from the list to establish relay points. The entire country will be divided into circles whose diameter will be the sending radius of the stations officially appointed, the circles overlapping and connecting up all strategic points. The messages will be received in each city and town, whereupon each operator will file a copy of the message with the postmaster, and receive a receipt, which will insure him credit for the work.

The next meeting of the Institute of Radio Engineers will be held on Wednesday evening, November 1st, at the Engineering Societies Building, New York. A paper by Messrs. Bowden Washington and T. H. Boyster on "A Determination of the Energy Losses in a Radio-Telegraph Transmitter" will be presented. An interesting new method of determining heat losses in transmitters will be described.

DAVID SARNOFF.

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High-Frequency Resistance Calculation

By SAMUEL LOWEY

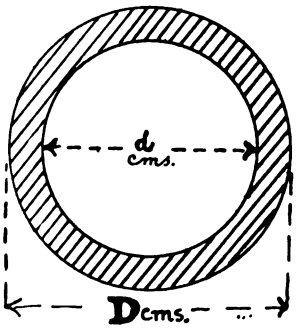

Fig. 1

The area of the shaded portion or ring (Fig. 1) $=\frac{\pi}{4}(D^2-d^2)$ sq. cms.

If the thickness, ϵ, of the ring is given, $d=D-2\epsilon$, so that the area of the ring (Fig. 2) will be

$$\frac{\pi}{4}\{D^2-(D-2\epsilon)^2\}=\pi\epsilon\,(D-\epsilon) \text{ sq. cms.}$$

If Fig. 2 is now considered as representing the cross-section of a conductor, the ring portion being the effective depth penetrated by a given high-frequency current, the resistance (per cm. length of conductor) to this current will be

(i) $\frac{\rho}{\pi\epsilon(D-\epsilon)}$, when ρ = resistivity.

The resistance of equal length of the conductor to a steady current will be

(ii) $\frac{\rho}{D^2\frac{\pi}{4}}$

The ratio $\frac{\text{High-Frequency Resistance (i.)}}{\text{"Steady Current" Resistance (ii.)}}$

$$=\frac{\frac{\rho}{\pi\epsilon\,(D-\epsilon)}}{\frac{\rho}{D^2\frac{\pi}{4}}}=\frac{D^2}{4\epsilon\,(D-\epsilon)}.$$

This equals $\frac{1}{4x\,(1-x)}$, if x is taken as the ratio of $\frac{\text{penetration}}{\text{diameter}}$ or $\frac{\epsilon}{D}$.

By substituting different values for x, a table may be made so as to show opposite to readings of $\frac{\epsilon}{D}$ the corresponding values of $\frac{\text{High-Frequency Resistance}}{\text{Steady Current Resistance}}$.

These are given in the scale Fig. 4. If $\frac{\epsilon}{D}=\cdot001$ the high-frequency resistance is 250 times the steady current resistance, while only three times if $\frac{\epsilon}{D}=\cdot092$.

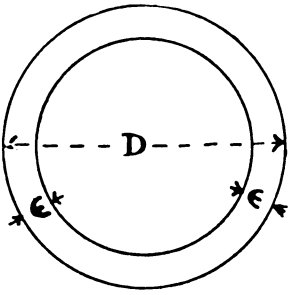

Fig. 2

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The depth of penetration (ϵ) may be obtained from the formula * $\epsilon = \frac{1}{\sqrt{2\pi u C w}}$, which (by substituting $2\pi n$ for w and ρ (the resistivity) for $\frac{1}{C}$) becomes $\epsilon = \sqrt{\frac{\rho}{4\pi^2 u n}} = \frac{1}{2\pi}\sqrt{\frac{\rho}{un}}$ or, if the material be assumed to be non-magnetic, $\epsilon = \frac{1}{2\pi}\sqrt{\frac{\rho}{n}}$.

This would be rather tedious to apply to a number of cases; so, in order that the operation may be simplified, the diagram (Fig. 4) has been made.

From this diagram, by following out the instructions given thereon, the value of ϵ for any conductor (not magnetic) at any frequency may be obtained.

If necessary, the "frequency" scale may be *multiplied* by 100, 10,000, etc., providing that the result be *divided* by 10, 100, etc.

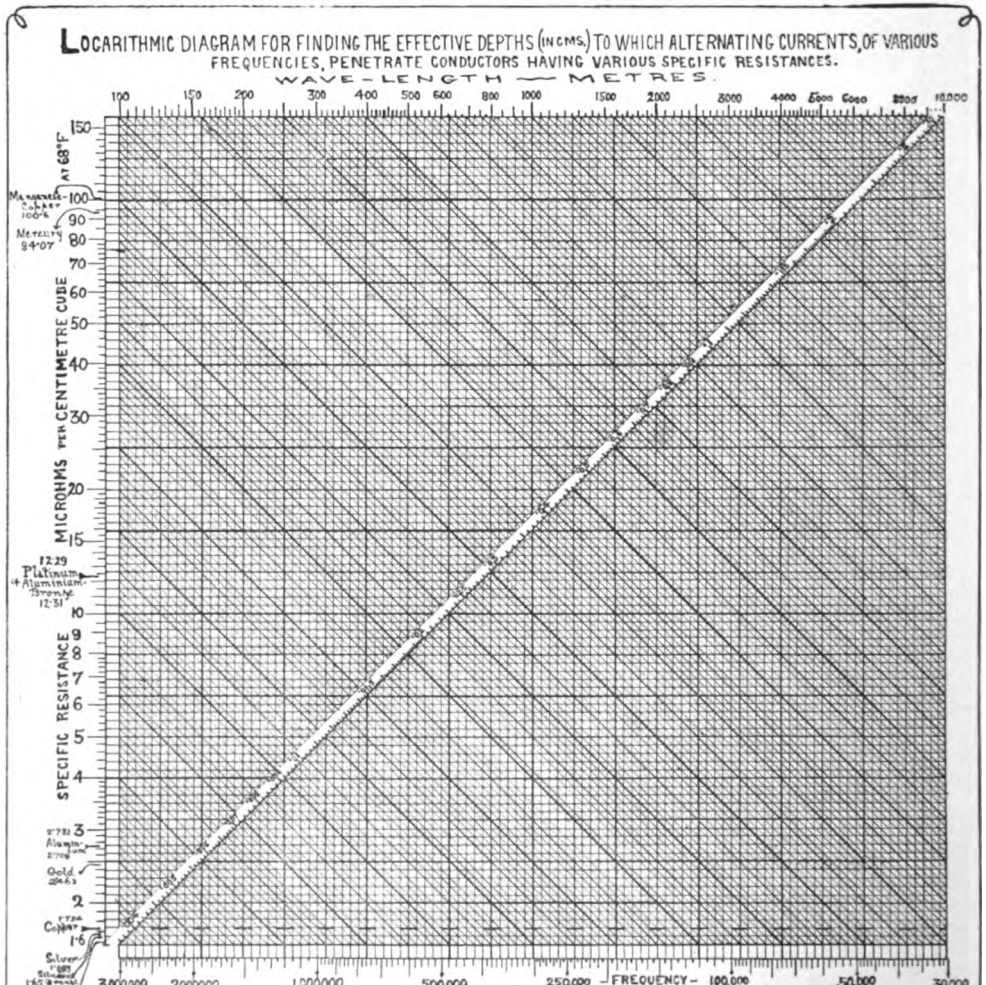
LOCARITHMIC DIAGRAM FOR FINDING THE EFFECTIVE DEPTHS (IN CMS.) TO WHICH ALTERNATING CURRENTS, OF VARIOUS FREQUENCIES, PENETRATE CONDUCTORS HAVING VARIOUS SPECIFIC RESISTANCES.
WAVE-LENGTH — METRES.
100 150 200 300 400 500 600 800 1000 1500 2000 3000 4000 5000 6000 8000 10000
MICROHMS PER CENTIMETRE CUBE AT 68°F.
SPECIFIC RESISTANCE
Manganese-Copper 100·6
Mercury 94·07
12·29 Platinum
Aluminium-Bronze 12·51
Gold 2·443
Copper 1·726
Silver 1·623
Phosphor-Bronze 1·6
3,000,000 2,000,000 1,000,000 500,000 250,000 FREQUENCY 100,000 50,000 30,000
FROM DESIRED POSITION ON "SPECIFIC RESISTANCE SCALE, PROCEED HORIZONTALLY
FROM " " " "FREQUENCY OR WAVE-LENGTH" " VERTICALLY
THENCE FROM JUNCTION UNTIL DIAGONAL SCALE IS CUT.

FIG. 3.

* Mr. Baillie's Article, p. 515, WIRELESS WORLD, October 1916 (q.v.).

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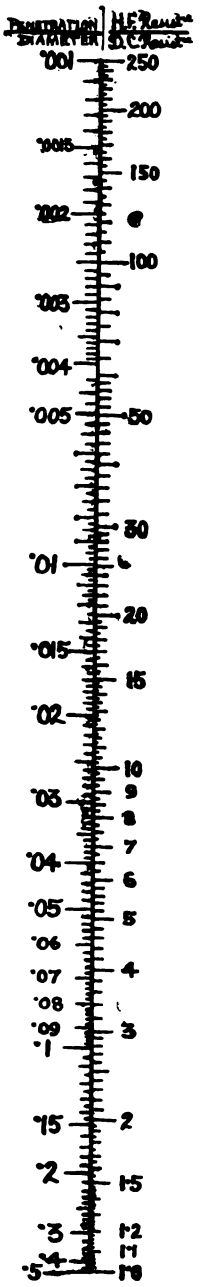

Fig. 4

To take a few examples.

Required: the resistance per cm. length of the following conductors compared with their resistance to direct-current.

——	$\frac{\text{Fig. 3}}{\epsilon}$	$\frac{\epsilon}{D}$	Fig. 4 $\frac{\text{H.F. Res.}}{\text{D.C. Res.}}$
14 S.W.G. Copper, at $n=$ 3,000,000 ·203 cm. diam....	·00381	·018	14·2
Aluminium - bronze, 14 S.W.G., $n=300{,}000$ ·203 cm. diam.	·032	·158	1·7
40 S.W.G. Copper at $n=$ 3×10^{10} ·0122 cm. diam. ...	·0000381	·0031	80

For conductors of rectangular section, providing that ϵ does not exceed half the thickness of conductor, the high-frequency resistance per cm. length equals $\frac{\rho}{\epsilon\,(\text{perimeter}-4\epsilon)}$.

United States Government and the Wireless Direction Finder

Recognition of Great Invention

The Hydrographic Office of the Marine Department of the United States of America points out to the International Bureau of the Telegraphic Union at Berne the fact that the direction indicator of radio-telegraph signals having been perfected, and having become of the utmost importance to navigation, it is necessary to show on marine charts not only the geographical position of coast stations and fixed stations, but also the altitude of the top of the pylons of these stations in comparison with the level of the sea and the height of these pylons above the ground. These two latter pieces of information not being in the possession of the Hydrographic Office, the latter would be very much obliged to Administrations who would give one or both.

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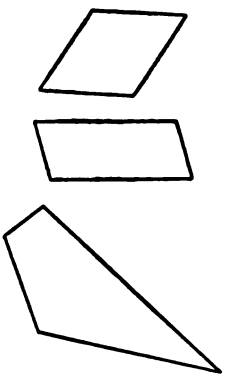
Instructional Article

NEW SERIES (No. 17).

The following series, of which the article below forms the seventeenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

QUADRILATERALS.

106. The term quadrilateral includes all plane figures which are completely enclosed by four straight lines. Special forms are :



1. *Parallelogram.*—Opposite sides are parallel.

2. *Rectangle.*—All angles are right-angles. (This is a special form of parallelogram.)

3. *Square.*—All angles are right-angles, and all sides are equal. (A special form of rectangle.)

4. *Rhombus.*—A parallelogram with all the sides equal, but angles not right angles.

5. *Rhomboid.*—A parallelogram with opposite sides only equal and angles *not* right-angles.

6. *Trapezium.*—Any other form of quadrilateral.

POLYGONS.

In the term polygon we include any plane figure with more than four sides or angles. If its angles and its sides are all equal it is a *regular polygon.*

The most important types of polygons are the regular polygons with :

(*a*) Five sides, called *pentagons,*
(*b*) Six sides, called *hexagons,*
and (*c*) Eight sides, called *octagons.*

107. In Fig. 95 we have the construction for drawing a regular polygon of any number of sides in a given circle. We first of all draw a diameter, AB, and divide it into as many equal parts as there are to be sides in the polygon ; in this case nine.

With A and B as centres, and radius equal to AB, draw two arcs cutting at C. Join C to the second point of division (from either A or B) and produce this line to cut the circumference of the circle at D. Then AD will be the first side of the required polygon, and can be marked off round the circumference as shown.

This method, though very convenient, is not as exact as that shown in Fig. 96. This shows the construction of a seven-sided figure (a septagon) in the given circle.

First draw a radius, AB, and then draw a tangent DBC ; this tangent must necessarily be at right-angles to the radius AB. With centre B and any convenient radius draw a semi-circle CED, and mark it off into the seven equal parts.

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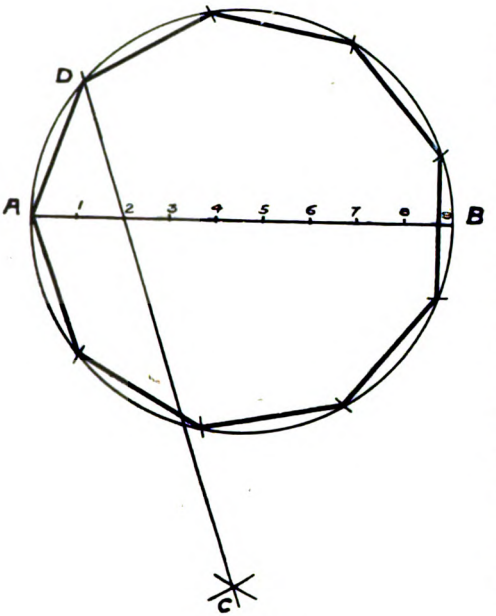

FIG. 95.

Straight lines drawn from B through each of these points of division will, when produced, cut the circumference of the circle at the points required for the polygon.

It will be seen that the method of Fig. 95 is much more convenient than this of Fig. 96, in that the former requires the division of a *straight line* into equal parts and the latter the similar division of a *semicircle*. Indeed, as this latter division would most probably be carried out by trial, it would be quicker to divide the circumference of the given circle straightaway into the required number of equal parts.

108. In Fig. 97 a regular polygon (a pentagon) is drawn *on the given base, AB*.

On BA produced, is drawn a semicircle, BDC, with centre, A, and radius, AB. This semicircle is divided into as many equal parts as the polygon is to have sides; in this case five. The straight line, $A2$, joining A to the second point of division from C, will be the second side of the pentagon.

Bisecting AB and $A2$ at right-angles we obtain, where these two bisectors cut, the point, E. A circle, drawn with centre, E, and radius, EA (or EB or $E2$) will be the bounding circle or *circumcircle* of the pentagon, so the remaining sides can be marked off round its circumference.

109. (*a*) To inscribe a circle in a given triangle, ABC (Fig. 98). Bisect any two of the angles of the triangle—say, angles B and C—with lines which cut one another at D. From D drop a perpendicular, DE, on to *any* side—say, BC—and with centre, D, and radius, DE, draw the required circle.

(*b*) To describe a circle about a given triangle, ABC (Fig. 99). Bisect any two sides—say, AC and CB—at right angles. Let the bisecting lines cut one another at D.

With centre, D, and radius equal to DA (or DB or DC) draw the required circle.

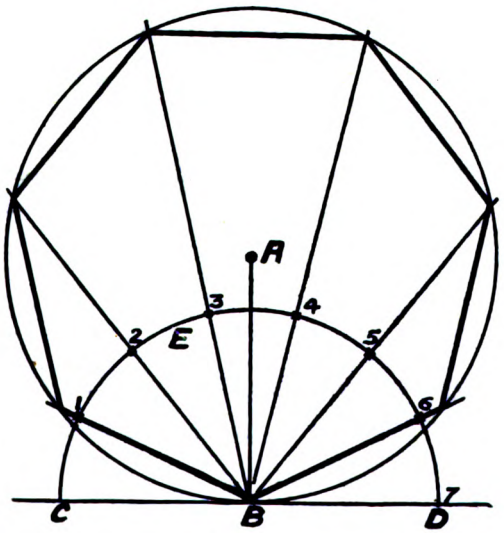

FIG. 96.

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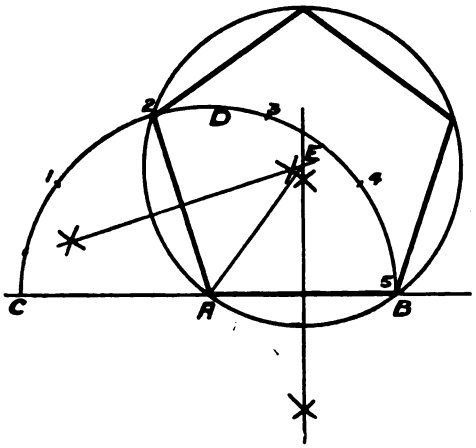

FIG. 97.

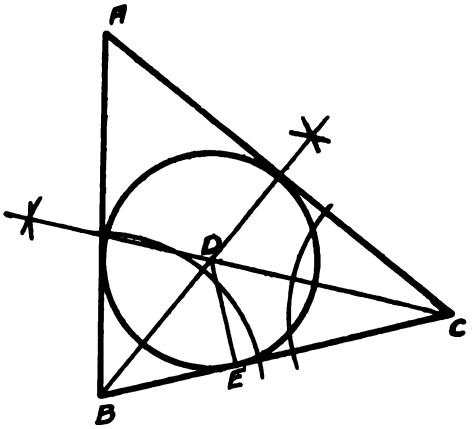

FIG. 98.

Solutions to Examples in Article XVI.

23. Prove $\cos(60°+A)+\cos(60°-A)=\cos A$.

$\cos(60°+A)=\cos 60°\cos A-\sin 60°\sin A$.

$\cos(60°-A)=\cos 60°\cos A+\sin 60°\sin A$.

Adding $\cos(60°+A)+\cos(60°-A)=2\cos 60°\cos A$

$=2\times\frac{1}{2}\times\cos A$ (because $\cos 60°=\frac{1}{2}$)

$=\cos A$.

24. Prove $$\frac{\sin 2\theta-\sin\theta}{\cos\theta-\cos 2\theta}=\cot\frac{3\theta}{2}$$

$$\sin 2\theta-\sin\theta=2\cos\tfrac{1}{2}(2\theta+\theta)\sin\tfrac{1}{2}(2\theta-\theta)$$

$$=2\cos\frac{3\theta}{2}\sin\frac{\theta}{2}$$

$$\cos\theta-\cos 2\theta=2\sin\tfrac{1}{2}(2\theta+\theta)\sin\tfrac{1}{2}(2\theta-\theta)$$

$$=2\sin\frac{3\theta}{2}\sin\frac{\theta}{2}$$

Therefore $$\frac{\sin 2\theta-\sin\theta}{\cos\theta-\cos 2\theta}=\frac{2\cos\frac{3\theta}{2}\sin\frac{\theta}{2}}{2\sin\frac{3\theta}{2}\sin\frac{\theta}{2}}$$

$$=\frac{\cos\frac{3\theta}{2}}{\sin\frac{3\theta}{2}}=\cot\frac{3\theta}{2}$$

25. Prove $2\operatorname{cosec}2A=\sec A\operatorname{cosec}A$.

$$2\operatorname{cosec}2A=\frac{2}{\sin 2A}=\frac{2}{2\sin A\cos A}$$

$$=\frac{1}{\sin A\cos A}=\frac{1}{\sin A}\cdot\frac{1}{\cos A}$$

$$=\operatorname{cosec}A\cdot\sec A.$$

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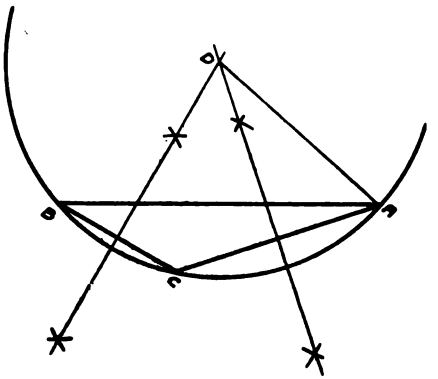

FIG. 99.

26. Prove

$$\frac{\cot^2 B+1}{\cot^2 B-1}=\sec 2B$$

$$\cot^2 B+1=\frac{\cos^2 B}{\sin^2 B}+1=\frac{\cos^2 B+\sin^2 B}{\sin^2 B}=\frac{1}{\sin^2 B}$$

$$\cot^2 B-1=\frac{\cos^2 B}{\sin^2 B}-1=\frac{\cos^2 B-\sin^2 B}{\sin^2 B}=\frac{\cos 2B}{\sin^2 B}$$

Therefore

$$\frac{\cot^2 B+1}{\cot^2 B-1}=\frac{\frac{1}{\sin^2 B}}{\frac{\cos 2B}{\sin^2 B}}=\frac{1}{\sin^2 B}\times\frac{\sin^2 B}{\cos 2B}$$

$$=\frac{1}{\cos 2B}=\sec 2B.$$

Wireless Custom for Shops and Hotels

The American Press recently recorded an interesting little incident in connection with the wife of the Columbian Minister of the U.S.A. She was travelling from South America on one of the fruit liners *en route* to New York when " rude Boreas " carried off her hat and made a present of it to Father Neptune. The consequence was that the lady, having lost her favourite headgear, was much distressed at the idea of arriving at New York with " nothing to wear "! What was she to do? In this case, as in so many others, wireless telegraphy came to the rescue. The lady went shopping by Marconigram and ordered a hat in New York. Simultaneously with her wireless order she informed her husband of her plight through the same beneficent agency, and requested him to see that the hat was delivered to her as soon as communication between the ship and shore was established. All went well, husband and hat duly presented themselves at the earliest possible moment, and both doubtless received the warm welcome which was their due.

Of course, such " shopping by wireless " is still in its infancy and has not yet reached the systematised stage to which, in course of time, it will doubtless attain. It has, however, become no uncommon occurrence for passengers to order their hotel accommodation through the medium of the wireless aerials of the vessels on which they travel; and, after all, general shopping would only be an extension of such a procedure. As matters stand at present the ship's newspapers, published on board with the news of the day as received by wireless, contain a number of hotel advertisements inserted for the express purpose of doing business in this way. No doubt in the course of time other business houses will follow suit and make arrangements for soliciting and executing orders borne by the ether waves. One of the leading French fashionable costumiers not long ago utilised the medium of the ocean newspaper for making an important communication to American buyers on their way to Europe, radiating their business announcement by wireless and arranging for it to be printed on board. We understand that the results were satisfactory, and a number of orders secured in consequence.

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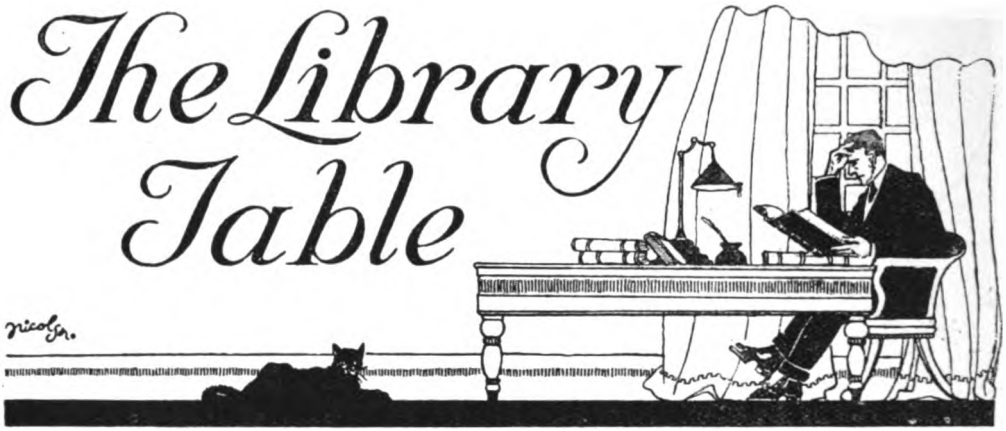

"How to Make Low-Pressure Transformers." Third Edition, with Additions. By Professor F. E. Austin. Published by the Author at Hanover, New Hampshire. 40 cents. London: E. and F. N. Spon, Limited.

This excellent little book, previous editions of which have been reviewed in our pages, is one of a series of small manuals which Professor F. E. Austin has put out within the last few years. All these books are eminently practical, and in this particular case the instructions for making efficient low-pressure transformers are all that could be desired. We note several improvements and additions in the present edition, notably a new and simple form of core construction described on page 14, and the special type of transformer for those who desire to experiment with different coil windings on page 16. How practical are the author's instructions and hints may be gauged from the fact that on page 20 Professor Austin describes how discarded condensed milk tins, varnish tins, and tin pails may be utilised to provide the material for transformer cores. These tins are really made of thin rolled steel coated over with a thin layer of metal tin, and if they are put in a hot fire, the solder and tin coating will melt off, leaving a thin metal, which can be annealed and softened by very slow cooling. The oxide which has formed on the metal in the fire is not removed, as this forms a useful insulating layer.

* * * * * *

"Final Digest for Marconi Students." By J. Henstock. Published by the Author at Wallasey, Cheshire.

This book consists of a large number of questions and answers regarding Marconi ship wireless apparatus and claims to provide students with useful instructions and directions when preparing for the Government examination. Some of the questions and answers are good, and some are fair, but a number are so hopelessly inaccurate and misleading that we should hesitate before placing the book in the hands of any student whom we wished to pass the examination successfully.

In order that we may not be thought to be biassed or prejudiced, we think it best to deal in some detail with the volume, and will first of all point out two conflicting statements which appear in Part I. We would mention straight away that the object of the book seems to be not the proper instruction of the student, but the

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deliberate cramming of his mind with sets of questions to which he is supposed to give parrot answers. We cannot but regard with disfavour the method of giving a question, followed immediately by the answer. Questions should be quite separate from the answers, in order that the student may test his knowledge. This he cannot do if the answer is given immediately under the query.

But to come back to our criticism of Part I. On page 11 we find the following: "It is not likely any serious fault will be found with either the potential transformer "or the main condenser, because it would take too long to remedy it, and time is "limited in an examination. A candidate, therefore, need not trouble himself much "about these parts of the apparatus. . . ."

On the next page we find: "as regards the emergency set, the most common "fault in the battery or accumulators is sulphating. It may be easily detected "because the specific gravity of the acid at the end of the charge will be less than it "was at the end of the first charge. The remedy for this is an extra charge." Now, if time is limited in the examination, surely there is not enough time to see about charging or discharging the accumulator. We will say nothing about the folly of teaching a student to ignore faults which cannot be conveniently brought within the limits of an examination.

In Part II, where we have a long series of questions and answers, we find, as the first specimen, the following illuminating information:—

Q. Describe the difference between high and low potential.

A. High potential has greater voltage than low potential.

Lower down we find:—

Q. What is a wave train?

A. A group of oscillations of one spark, fifty sparks equals one dot.

A reply such as this would be sufficient to fail a man in any examination. Still on the first page we find again:—

Q. What is a Bradfield insulator for?

A. To provide insulation and water-proof lead-in for aerial, and also to *protect it from lightning*. (The italics are ours.)

On page 11 we read:—

Q. What is meant by amplitude?

A. Height of wave above its centre maximum of half a swing.

This is unintelligible, but not so surprising as the next question but one, *i.e.*:—

Q. Does it matter what number of volts and ampères are used in a 1½ k.w. set?

A. No, so long as they do not exceed 1,000 volts.

By this time we have begun to see Wireless in a new light, and when in the middle of page 15 we find:—

Q. What is the alteration of the spark gap?

A. 120.

it seems that the whole of Wireless is altered. Page 16 affords the following:—

Q. Why is alternating current used in a 1½ k.w. set?

A. Because it is faster and needs no attention like a hammer break.

Q. Are the starter and field regulator the same?

A. Practically so, with slight modifications.

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On page 19 we are told that the guard lamps are connected one in shunt to the armature and the other to the field of the converter—quite an interesting piece of news to those like ourselves, who thought they were connected across the D.C. and A.C. sides of the machine respectively. Other questions and answers which need no comment are :—

Q. What happens if six of the plates in the condenser are broken ?
A. It would shorten the wave length.
Q. What is meant by the word oscillation ?
A. Current surging backwards and forwards, many thousands of times per second, and gradually dying out.
Q. What is the purpose of the earth arrester terminal ?
A. It saves using a change-over switch ; prevents operator *hearing his own signals*, and allows him to be interrupted in the middle of a message. (The italics are ours.)
Q. What are the condensers in the multiple tuner for ?
A. To tune to the wave-length of the transmitting station. These condensers in certain cases might be dispensed with, but it depends on the size and length of the aerial.
Q. How do you test the receiving apparatus ?
A. With a buzzer on a tapping iron band.

Last of all, we think the following piece of information will doubtless create a revolution in the scientific world :—

Q. Would an alternating current dynamo do ? (For charging accumulators.)
A. No.
Q. Why not ?
A. Because alternating current rapidly changes its direction and polarity many thousands of times per second (Some alternator [!]—ED.), and therefore would charge and discharge the cells all the time and would ruin them.

Part III. consists of questions and answers on the P.M.G. Handbook, and Part IV. gives information regarding the form of application for attending the Postmaster-General's examination.

The fact that this is a second edition of this book makes the inclusion of such errors as we have pointed out unpardonable.

Radiotelephony in Argentina.

A laboratory is being fitted up at the Radiographic station at the Darsena Norte, for the purpose of making experiments in radiotelephony. It is hoped to be able to effect communication over a distance of 200 miles.—*The Electrician.*

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Personal Notes

We learn with regret from the *South London Press* that Gunner T. G. Gayner, R.G.A., of Roseberry Road, Brixton, was killed in action on November 1st. Gunner Gayner was a wireless operator, and was killed by the bursting of a shell. Prior to the war he was engaged as a salesman at a wholesale toy merchant's in Clerkenwell, and leaves a widow and child four years of age. His officer, communicating the sad tidings to his father, said he was very much liked by all his battery for his courage and helpful nature.

* * * * * *

Percy Bootham, of Bradford, a wireless operator in the R.N.V.R., is officially reported lost at sea on November 5th. He was 21 years of age.

* * * * * *

We learn from the *Bath Herald* that Sapper Telegraphist Charles Black, R.E., is back in Bath on leave, after seeing service since the beginning of the war. He was for seven years in the choir at St. Luke's, and while there was taught wireless telegraphy by the late Rev. G. E. Doudney, who had his own installation, which was described some time ago in the WIRELESS WORLD. Upon enlisting, Sapper Charles Black first joined the Royal Marines, taking duty on board a wireless experimental ship. He then served in the ranks with the Royal Marines, taking his full share of the infantry work of the Royal Naval Division. He was in the famous fighting at Antwerp, at the Dardanelles, Egypt, and Salonica, and a few months ago passed his examination in wireless telegraphy and was transferred to the Royal Engineers in France as a Sapper Telegraphist. He is now a wireless operator, and has been wounded twice, once at Gallipoli and once at Salonica.

* * * * * *

Mr. Samuel S. Taylor, a solicitor of Derby, and one of the county coroners, has joined the wireless telegraph section of the Royal Navy, and has been given warrant rank. Many of our readers will remember Mr. Taylor as President of the Derby Wireless Club in pre-war days.

* * * * * *

Congratulations to Lieut. F. C. Cross, R.N.R., on his promotion to Lieut-Commander, R.N.R. Lieut. Cross is the headmaster of the White Star Training Ship *Mersey* and the author of " Wireless Explained."

* * * * * *

Best wishes to Mr. Horace R. Neate on his marriage to Miss Dorothy

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OPERATOR S. J. TAYLOR.

Claire Wall, of Cheltenham. Mr. Neate has seen service as a wireless operator at Suvla Bay on H.M.S. *Morea*, but since his discharge from the Naval Service has joined as a private in the Army. Mrs. Neate was a Red Cross nurse at Boddington V.A.D. Hospital.

* * * * *

Hearty congratulations to Mr. A. Pink, chief operator at the Towyn wireless station, who was married on November 11th to Miss Meir Iona Roberts. The ceremony was conducted at the English Calvinistic Methodist Capel, at Aberdovey, Merionethshire, and the honeymoon was spent at Barmouth.

* * * * *

We have more than once referred in our columns to the special attention paid to the welfare of the messenger service of Marconi's Wireless Telegraph Co., Ltd. As many of our readers are aware, facilities are given to these young men to study wireless telegraphy in the Marconi House School, and the latest to obtain his certificate is Mr. Samuel John Taylor, who successfully obtained a first-class certificate at the beginning of December. Mr. Taylor has now been appointed to the Marine Operating Staff, and by the time this magazine appears will be on the high seas, carrying out those duties which are of such great importance at the present time. We congratulate him upon the good progress he has made.

* * * * * *

We are able to publish this month a photograph of the late Mr. Hodgson, whose sad death in an aeroplane accident we recorded in our last issue.

* * * * *

Friends of Mr. E. A. Planterose, who was for some time on the Marine Operating Staff of the Marconi Company, will be interested to hear that he has obtained a commission as Sub-Lieut. in the R.N.V.R., and is at present training for Observer in the Royal Naval Air Service. Mr. Planterose joined the Marconi Company in April, 1911, and served on a number of vessels, including the ill-fated P. & O. liner, *Arabia*. In 1914, he resigned to take up an appointment as Traffic Instructor in the Chilian Navy, and served in the wireless stations at Llanguihue, Talcahuano, and Valparaiso. In September of this year he patriotically resigned his contract and came to England to take up the commission to which we have above referred.

THE LATE PETTY OFFICER W. H. HODGSON.

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SUB.-LIEUT. E. A. PLANTEROSE.

We wish him every success in his new appointment.

* * * * *

It is with sincere regret that we have to record the death of 2nd Lieut. Percy J. Gibbons, who was killed in action on October 17th in France, when temporarily attached to the Royal West Kent Regiment. His commanding officer wrote as follows :—" He had been attached to the battalion under my command for a few weeks before his death. He was killed leading his platoon in an attack on the German lines. The battalion had been holding some front-line trenches, under very trying circumstances, for some few days before attacking. I happened to see a good deal of Lieut. Gibbons during these days, and was much impressed with his good work ; he was cheerful and did much to encourage his men, and by his death the Service has lost a very promising young officer. I think he was killed instantaneously on the battlefield, together with many others of my officers."

Lieut. Gibbons was a member of the accountant's department at Marconi House, and enlisted in the Royal Fusiliers shortly after the outbreak of war, together with several other members of the office staff. He only obtained his commission just recently, and he was much liked by those who knew him. Great sympathy will be felt with his mother, as he was her only child.

* * * * *

Among the recently announced awards was that of the D.S.O., presented by the King to Flight Sub-Lieutenant Pulling, of the Royal Naval Air Service, for his brave and courageous work in the destruction of a Zeppelin off the East Coast of England. Sub-Lieutenant Pulling was a member of the Post Office Wireless Staff before taking his commission, and will probably be known to many of our readers. Not only wireless men, but the whole of the British nation are proud of this young officer in the work he has done in destroying a cowardly raider of the air.

Photo] [*Farringdon Photo Co.*

FLIGHT SUB-LIEUT. PULLING, D.S.O.

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Patent Record

9335. July 3rd. F. Murgatroyd. Continuous wave dynamo electric machines.

9537. July 6th. Marconi's Wireless Telegraph Co., Ltd., and I. Shoenberg. Frequency measuring instrument for electric currents.

9649. July 8th. G. Constantinescu and W. Haddon. Transmission of energy by wave motion.

9766. July 11th. British Thomson-Houston. Regulators for polyphase transmission.

9812. July 12th. British Thomson-Houston. Systems of polyphase transmission.

9833. July 12th. Indo-European Telegraph Co. and A. H. Morse and H. Rivers-Moore. Electric oscillating or wireless systems and apparatus.

9927. July 14th. British Westinghouse Electrical Manufacturing Co. Production of asymmetric potential waves. (Convention date, U.S.A., July 15th, 1915. Patent No. 100,893. *Open to inspection.*)

9937. July 14th. M. Breslauer. Dynamo electric power transmission apparatus of unipolar type. (Convention date, Germany, July 10th, 1914. *Accepted.* Patent No. 100,894.)

9938. July 14th. British Thomson-Houston Co., Ltd. Protection of electric transmission systems.

10096. July 17th. I. Chortik. Method of producing high frequency oscillations.

10103. July 18th. I. Chortik. Generation of high frequency currents.

10096. July 18th. J. Bethenod and E. Girardeau. Spark gaps for Wireless Telegraphy. (Convention date, France, July 21st, 1915. Patent No. 100,957. *Open to inspection.*)

10122. July 18th. Lee de Forest. Oscillating audions. (Convention date, U.S.A., July 22nd, 1915. Patent No. 100,959. *Open to inspection.*)

10176. July 19th. Marconi's Wireless Telegraph Co., Ltd., and R. H. White. Means for opening and closing electrical circuits.

10205. July 20th. J. Pederson. Power generating and transmitting devices.

10227. July 20th. A. E. McColl. Protective device for alternating current electric systems.

10558. July 26th. G. O. Squier and L. Cohen. System of electrical signalling.

10576. July 26th. J. Bethenod and E. Girardeau. Wireless Telegraphy and Telephony. (Convention date, France, August 10th, 1915. Patent No. 101,148. *Open to inspection.*)

10627. July 27th. H. K. Harriss. Transmitting apparatus.

10713. July 28th. E. R. Clarke, S. R. Mullard and Ediswan Electric Light Co. Valves for receiving or producing wireless current.

10722. July 28th. I. Chortik. Means for producing high frequency oscillations.

10850. August 1st. British Thomson-Houston Co., Ltd. (General Electric Co., U.S.A.) Electron discharge apparatus.

10905. August 2nd. British Thomson-Houston Co., Ltd, and R. C. Clinker. Wireless transmitting system.

10999. August 3rd. W. Cross. (*Svenska Akt. Gas accumulator.*) Detectors for Wireless Telegraphy.

10958. August 3rd. R. A. Fessenden. Apparatus for transmitting and receiving sound waves through the ground. (Convention date, U.S.A., October 7th, 1915. Patent No. 101,968 *Open to inspection.*)

Share Market Report

LONDON, *December 11th*, 1916.

Business in the Share Market has been very quiet during the past month. The closing prices as we go to press are: Marconi Ordinary, £2 15s.; Marconi Preference, £2 6s. 3d.; Marconi International Marine, £1 17s. 6d.; American Marconi, 15s.; Canadian Marconi, 9s. 6d.; Spanish and General Wireless Trust, 10s.

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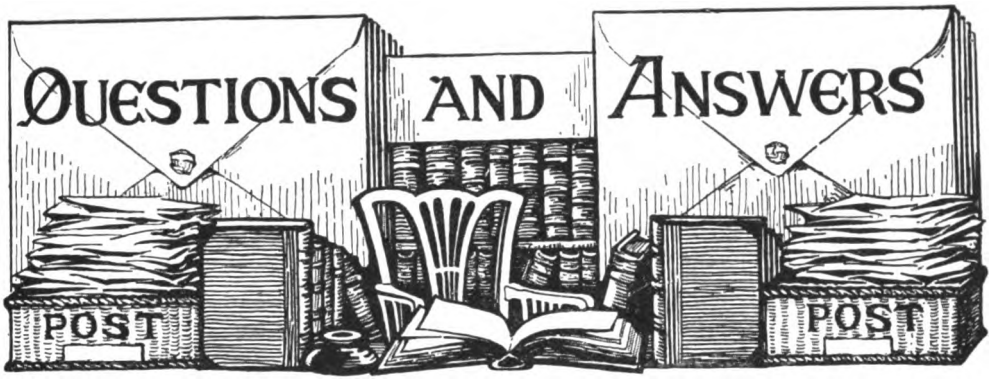

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.*

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

K MACB. (Cricklewood).—An article on "Operating in the Merchant Service" appears in this issue.

C. L. C. (Willesden).—The design for a wireless telephone transmitter given in the sketch attached to your letter is interesting, but it would not work owing to the fact that the selenium would not vary its resistance rapidly enough to enable it to be used in such a connection. Selenium takes quite an appreciable time to vary its resistance when a beam of light falls upon it.

D. M. J. (Plumstead).—Officer-in-Charge, Royal Naval Air Service, Wireless Section, Wormwood Scrubbs.

M. G. (Bradford).—(1) The age limit for any applicant for the Marine Service of the Marconi Company is 25, and this limit has not been relaxed during the war. (2) A few shipping companies employ their own operators, but we have no information regarding their conditions of employment. In any case a man of 34, with no sea experience would probably find difficulty in obtaining such employment. (3) Yes, there are occasional openings for English operators in the Colonial Mercantile Marine; but here, again, we come to the question of age.

J. S. (Cardiff).—See the article entitled "Naval and Military Wireless Telegraphists, Their Status and Conditions of Training," in our October issue.

J. W. (Blackpool).—See an article on "Operating in the Merchant Service," in this issue.

L. A. W. (Thirsk).—(1) You will find full details of the Marconi uniform and some useful hints on outfit in the *Wireless Diary and Note Book* just published. This is a very useful pocket-book and diary and the information contained therein should prove very valuable to you. (2) With regard to etiquette on board ship and the conduct towards the captain and other officers, there is nothing much to be said beyond that the operator is required to bear himself in a gentlemanly manner. The commander should be saluted, and it is considered courteous to salute the bridge when one's business takes one there. It is wise to respect little personal peculiarities of the commander, and a quiet chat with one of the officers on joining should make the way quite smooth. If an operator wants to make himself thoroughly unpopular he has only to "give himself airs," and if a new man will use his common sense and tact he is not likely to go wrong.

PRIVATE T. (H.M.S. ——).—If you carefully study the books you mention in your letter you should be in a position to pass the examination after a short finishing course. We do not think, however, that a week would be sufficient; a month would probably be the shortest time in which you could get the necessary practical training. P.M.G. Examinations are held at regular intervals and just as frequently as there is need for them. A postal course should be of great assistance to you as by answering the various questions which would be put to you and having your answers criticised, you should be able to learn your weak points. The value of a correspondence course is not so much in the text-books with which one is provided, but in the criticisms of one's work which are given.

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E. J. G. (Upper Holloway).—See an article on "Operating in the Merchant Service" in this issue.

K. C. (Denmark).—Most of the crystals used in wireless telegraphy are rather complex bodies. Molybdenite is a bisulphide of the metal molybdenum, bornite is a copper ore, galena a lead ore consisting mostly of the sulphide of lead, iron pyrites is sulphide of iron, silicon and tellurium are elements, and plumbago is a form of carbon, chalcopyrite is complex copper ore consisting largely of copper sulphide and also containing iron. Zincite is an ore of zinc. Perhaps one of our readers who is a student of geology would like to contribute an article on crystal detectors from this point of view; we are sure it would be welcomed. With regard to your last question, wireless telegraphists in the British Mercantile Marine are required to be British subjects. The Société Anonyme Internationale de Télégraphie Sans Fil, Marconi House, Strand, W.C., which controls the wireless service on a large number of foreign vessels, would, however, give consideration to your application when you are free.

SAPPER L. B. W. (Epping).—There are vacancies at the present time for electricians with wireless knowledge in the wireless section of the Royal Engineers. See announcement on another page.

A. B. C. (Gosport).—See Post Office Circular, November 21st, 1916, No. 2323.

SPARK GAP (Tralee).—(1) The questions at the P.M.G. Examinations are oral and are not published. (2) *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, 3s. 6d., post free, 3s. 10d., from the Wireless Press, Limited. (3) and (4) Yes, the apparatus you mention is very good. The same firm supply, we believe, some cheaper sets, and you should write to them for particulars. (5) See advertising pages of this issue.

P. S. (Westcliff-on-Sea).—An article on the wireless service of the Navy appeared in our October issue. If this does not contain the information you require please write to us again.

P. J. L.—To explain clearly the working of vacuum valves would take more space than we can give in these columns. We hope, however, to publish an article shortly in which the working of all forms of vacuum valves will be thoroughly dealt with.

R. B. P. (Essex).—THE WIRELESS WORLD examinations have been suspended during the war.

S. G. (Tocra).—Thank you for your letter and kind wishes. In reply to your first question, the best arrangement for radiation is always that in which you get the best spark, and if you vary the fixed electrodes until such an adjustment is obtained, you may be sure you are getting the best radiation. We understand from your second question that you are increasing the wave length of your detector circuit by placing a variable condenser in parallel with the condenser of the tuner. This is quite a good arrangement, and is, in fact, similar to that adopted in the multiple tuner, where the capacity of the condensers is augmented by three fixed condensers attached to the studs controlled by the tuning switch. In reply to your third question, we regret we cannot publish any information regarding wave lengths of particular wireless stations, neither can we state which station sends out any particular programme of press. (4) Only British subjects can be employed in the wireless service of the British Mercantile Marine. The Marconi International Marine Communication Co., Ltd., Via del Collegio Romana 15, Rome, controls the wireless installations on Italian vessels, and you should make application to them after the war if you wish to enter such a service. We are very glad to hear that THE WIRELESS WORLD is so useful to you.

SPECIAL NOTICE.

Readers will considerably facilitate the work of our Expert if they write their questions on one side of the paper only, and make their queries as clear and full as possible. Questions should be numbered for reference and should not exceed four.

WIRELESS INSTRUCTOR WANTED.—Must be good technical man (specialise Marconi Sets). Salary £160 per annum to commence.—Apply Box 251, THE WIRELESS WORLD, Marconi House, Strand, W.C.

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MARCONIGRAM
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IN CONNECTION WITH
MARCONI WIRELESS TELEGRAPH COMPANY
OF AMERICA
Send the following message "VIA MARCONI", subject to the terms on back hereof, which are hereby agreed to.
The White House,
Washington, November 15, 1916.
His Imperial Majesty the Emperor of Japan at Tokio.
The Government and people of the United States of America send greetings to your Imperial Majesty and to the people of Japan and rejoice in this triumph of science which enables the voice of America from the far West to cross the silent spaces of the world and speak to Japan in the far East hailing the dawn of a new day. May this wonderful event confirm the unbroken friendship of our two nations and give assurance of a never ending interchange of messages of good will. May the day soon come when the voice of peace, carried by these silent messengers, shall go into all the world and its words to the end of the world.
Woodrow Wilson.
GRAM
RELESS
ABLE CO. Inc.
RAPH COMPANY
OF AMERICA
Send the following message "VIA MARCONI", subject to the terms on back hereof, which are hereby agreed to.
MESSAGE OF THE EMPEROR OF JAPAN TO PRESIDENT WILSON
It affords me much pleasure that the first use of the installation of wireless telegraphy between Japan and the United States has been to transmit your cordial message. In return I send this expression of my thanks for the good wishes exhibited toward me and my people, and of the hearty desire entertained throughout Japan for the continued prosperity and welfare of the United States.

Photos: Dr. Wilson (Underwood & Underwood); Emperor of Japan (Exclusive News Agency).

Bridging the Pacific

Opening of the United States-Japan Wireless Service.

AT half past four in the morning, San Francisco time, on Wednesday, November 15th, an interchange of messages between President Wilson and the Emperor of Japan marked the opening of the new Transpacific Wireless Service, inaugurated by the Marconi Company. Whilst in Europe the greatest war in history was raging with unabated fury, here in America and Japan messages of peace and goodwill, of congratulation and hope, passed backwards and forwards across the world's greatest wireless span. After the two rulers had exchanged the messages reproduced at the head of this article the Governor of Hawaii sent salutations to the Premier of Japan and received a reply couched in the friendliest terms; the Mayors of Honolulu and Tokio exchanged courtesies; the President of the San Francisco Chamber of Commerce and Baron Shibuzawa of the Japanese Chamber of Commerce sent friendly greetings to each other; the editors of American newspapers exchanged fraternal messages with the editors of the leading newspapers in Japan; diplomats exchanged compliments; messages from Senatore Marconi and his American associates passed over the circuit and a host of congratulatory messages of all sorts poured through the connecting link at Honolulu.

But for the war, far more attention would have been paid in this country to this

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latest triumph of electricity and ether wave communication, for the distance between the San Francisco station and the corresponding installation at Funabashi is no less than 4,200 miles. The whole of the distance is covered with but a single relay, a high power station at Honolulu forming the connecting link. Direct communication between San Francisco and Japan has several times been accomplished and when conditions are good the relaying of messages at Honolulu will be unnecessary.

Behind the announcement that the wireless service established between the United States and Japan by the Marconi Wireless Telegraph Company of America was inaugurated on November 15th lies a story of overcoming seemingly insurmountable difficulties; of the accomplishment of engineering feats that apparently defied the most skilled efforts; of the battling with nature in remote climes and finally the resultant triumph—the forging of another link in the world-wide radio chain and the unlocking of other gates to the commercial world of the Orient.

The history of the United States—Japan service began about four years ago when the idea of encircling the world with radio stations was evolved.

The execution of the plan having been decided upon, the far-reaching machinery of the Marconi system was immediately set into motion. The American Marconi Company was called upon to build the following units: Trans-Atlantic stations at New Brunswick and Belmar on the New Jersey coast to send and receive messages to and from corresponding stations in Great Britain; sending and receiving stations respectively at Bolinas and Marshall, California, linking the Pacific coast with the Hawaiian stations, Kahuku and Koko Head; two similar stations in Manila, the Philippine Islands, and receiving and transmitting stations at Marion and Chatham, Massachusetts, to connect in Norway with Stavanger and Naerbo.

One of the first difficulties that came up in connection with the construction of the stations was that of transportation of materials. Practically all of the structural steel and machinery for the Kahuku and Koko Head stations was conveyed by steamship from New York to the Port of Mexico, across the Isthmus of Tehuantepec, and thence by boat to Honolulu, the trip occupying about five or six weeks. The cement and lumber were shipped from California.

Koko Head, which was planned originally as the receiving station in Hawaii, and will be used as the demands of the service require it, is about ten miles east of Honolulu. There were two ways to transport the material to this point; either by carting it by road, a plan which had many drawbacks because of the condition of the thoroughfare, or by transporting it by boat and unloading it on the beach. A trial of the latter plan was decided upon, and a consignment of steel was loaded on a small steamer commanded by a Hawaiian who had earned a reputation for skill in manœuvring his craft in and out of the numerous difficult landings. A barge and a launch accompanied the steamer, for the latter could not be navigated over a bar on the route to Koko Head, and it was planned to unload the material on the barge and have the latter towed ashore by the small steam-propelled boat. All went well until the launch with the barge in tow tried to shoot through the breakers. The first line of rollers was passed in safety, but a short distance farther on two large combers submerged the barge and it sank. Thus ended the attempt to effect transportation by the sea.

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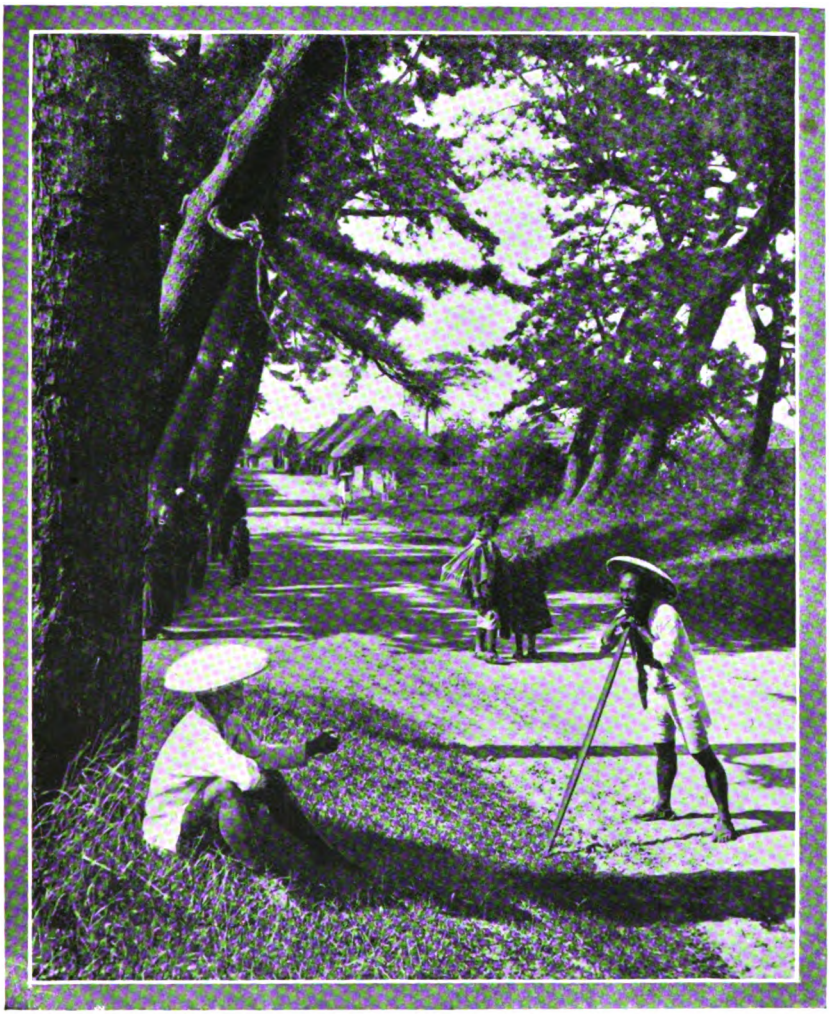

Photo: Underwood & Underwood.

ON THE TOKIO ROAD, NEAR THE FUNABASHI STATION.

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Meanwhile the experiment of conveying the material by road was being tried. The caravan, laden until the wheels of the wagons creaked and groaned, started from Honolulu soon after midnight and ran into a tropical rainfall, after it had proceeded only a few miles. The road, which was built of red clay mud, softened and became so slippery that the wagons could not be driven in a straight line, the rear wheels slipping off to one side wherever the surface of the thoroughfare sloped. As a result, material fell from the vehicles, parts of harness broke, wheels were put out of commission, and it was finally necessary to shift most of the loads, double up on the teams and bring the material piecemeal to the site of the station. Notwithstanding this discouraging experiment, the trucking was continued by means of the road route, although the horse-drawn vehicles were discarded and automobiles substituted.

Koko Head, located on the Island of Oahu, the third in size of the Hawaiian group, is known as the dryest point on the island. The land is undeveloped and is used only for cattle grazing, even the latter getting little nourishment from the scanty surface growths. In fact they frequently perish because of the lack of fresh water. The inadequate water supply threatened to cause considerable hardship among the engineers and station builders. It was found easy to obtain well water, but it ran about forty grains of salt to the gallon, which destroyed its value for drinking purposes, and after scouring the hills in search of a supply it was decided to distill all water.

From the operating house as a centre, the San Francisco aerial extends southwestward, carried on five 330-foot masts to an anchorage. The Japan aerial extends from the operating house almost due east. The first two masts are of the standard sectional type, 430 feet in height, the first being on level ground and the second on a hillside. From the latter point the aerial makes a span of more than 2,000 feet to the top edge of Koko Head, an extinct volcano at an elevation of 1,194 feet above the sea level; here there was not room enough to erect a sectional mast, only about forty square feet being available for a self-supporting structural tower, 150 feet in height. The tail end anchorage is far down on the inside of the crater. The balancing aerial, which is employed in both sets of antennæ, is on self-supporting towers, each of which is 100 feet in height. The difficulty in erecting these masts was largely due to the fact that two of them and the anchorage were located in a pond and it was necessary to sink caissons in order to lay the foundations.

The problems of construction at Kahuku, which is now being employed both as a sending and receiving station, were not as great as those at Koko Head, although the former is the largest wireless station in the world. From the power house the San Francisco transmitting aerial extends southwestward, supported by twelve masts, each of which is, 325 feet in height; the Japanese aerial extends to the south-east supported by twelve masts, each being 475 feet in height. The subsoil at the station is made up of porous coral rock, and consequently considerable difficulty was experienced in putting down foundations for the power house and masts. In all of the excavations for the mast anchorage foundations were built in the form of water-tight wooden cribs into which concrete was poured. Different sections of the site required different treatment, but generally the trouble was due to the presence of water in the subsoil, a factor, however, which added to the facility of operating the station.

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THE STATION AT BOLINAS, CALIFORNIA, FROM WHICH THE MESSAGES ARE FLASHED TO HONOLULU AND JAPAN.

The task of constructing the Bolinas station involved taking into consideration the fact that most of the material for erection purposes—the mast sections and wire rope for the eight masts, each 325 feet in height, and the steel work and machinery—was manufactured in the Eastern part of the United States, and in order to transport it to Bolinas, which is about fifteen miles from San Francisco, it was sent from New York by boat to the Isthmus of Panama, across the Isthmus by rail and thence by water again to San Francisco. As there was no railroad transportation available from the latter city to Bolinas, it was necessary to ship a considerable part of the material by water route from San Francisco, unload it at the wharf at Bolinas Bay and haul it by motor trucks to the site of the station. A sand bar with a shallow opening through which the tide races obstructs Bolinas Bay, making it impossible for craft of considerable size to reach the wharf except during high tide. In addition to these handicaps there was the necessity for rushing the work in order to make all the progress possible during the season of comparatively few storms.

As was the case at Koko Head, much difficulty was met with in obtaining a water supply. This was due to the fact that the ground is full of cracks caused by earthquakes and that the salt water from the Pacific seeped in. The solution of this vexed question was found, however, by damming a creek and installing a small pumping plant and a tank.

At Marshall, the receiving station, twelve miles north of Bolinas on Tomales

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Bay, there were perhaps fewer obstacles to be overcome than at the other stations.

The automatic sending and receiving apparatus plays an important part in wireless communication between the Occident and the Orient. The sending machine somewhat resembles a typewriter and will make possible the transmission of more than 100 words a minute. Under the automatic system, 10 or 100 messages can be filed at the same time at the office of the Marconi Company in Honolulu. They will be distributed among the necessary number of operators and the dots and dashes punched in a paper tape by a machine. This tape is fed into an automatic sender and the signals conveyed by land line to Kahuku where the dots and dashes actuate a high-power sending key, automatically energising the aerial instantaneously with the feeding of the tape in the station, thirty miles or more away. At the transmitting station the dots and dashes operate magnets of the high-power sending key in the main energy circuits and the signals are flashed to the points which the destination of the message calls for, either Marshall or Funabashi. If the message is destined for Marshall it will be received on a specially constructed dictaphone machine, each cylinder, as soon as it is filled with the dots and dashes, being handed to an operator who will transcribe it into a typewritten message by means of a dictaphone machine running at normal speed.

Such were the difficulties, the achievements and a few of the problems met with. After the stations had been completed there was a long period of tests and trials. The first results of these were marked by the opening of the service between Hawaii

Photo: Exclusive News Agency.

A SCENE ON THE CANAL AT TOKIO.

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and the United States on September 24th, 1914. On February 2nd, 1915, the station in Ochiishi, Japan, it was announced by newspapers of that country, had received messages from the Kahuku station. Prior to picking up the signals of the Kahuku station Ochiishi was receiving messages from a steamship 1,100 miles off the Japanese coast. The Ochiishi operators declared that messages from Hawaii were clearer than those from the steamship, notwithstanding the fact that the distance was more than three times as great. This was only one indication of the great range of the Kahuku station, for while tests were being carried on with the station in Funabashi, near Tokio, Japan, which was selected as the Japanese unit to communicate with the Hawaiian stations, inquiries regarding the spark and wave-length of Kahuku were received from Porto Rico, the Falkland Islands, New Orleans and New Zealand, where the signals transmitted by Kahuku were easily read.

At ten o'clock in the morning, New York time, and midnight, Tokio time, of the day appointed for the opening of the service, the cumulative result of the three years of study and effort which Edward J. Nally, Vice-President and General Manager of the American Marconi Company, and the members of his staff had devoted to the task of establishing communication with Japan was signalised by an exchange of messages between notables in the United States and the former nation. As an illustration of the operation of the service, it can be stated that a message from President Wilson to the Emperor of Japan, at Tokio, began its radio flight at the Bolinas station, from which, with the speed of a lightning flash, it took an unerring course across the Pacific and was received at the Kahuku station, spanning a distance of 2,087 miles. Quickly it was copied at Kahuku, given a new impetus, and sent speeding across the space of 4,140 miles that it had to traverse before reaching Tokio. In a similar manner the reply of the Emperor was dispatched to President Wilson. The message was transmitted from Funabashi and relayed at Kahuku to Marshall, which station has direct communication with the Western Union Telegraph Company, over whose wires traffic is forwarded. In Japan connection is made with the Japanese Imperial Telegraph system to all points in the Orient.

All of the communications between the United States and the Hawaiian and Japanese stations are transmitted in English or French. The Funabashi station is controlled by the Japanese Government and has two staffs of operators, military and civil, being employed by the Department of Posts and Telegraphs for commercial business, as well as by the Government.

There will be two classes of service between San Francisco and Japan, a full-rate or expedited service at eighty cents per word, a reduction of forty-one cents per word from the existing cable rates, and a deferred half-rate service at forty cents per word, the lowest cable rate at present being $1.21 per word.

This linking of two nations by wireless is simple in the telling, and in time will doubtless be accepted as a part of the scheme of general conditions in communication. But the men who brought it about, who spent days and nights in determining the solutions of vexed questions, who conducted tests regardless of time and weather, who journeyed to distant parts of the world to blaze the initial path of the project—they will long remember the romance and the difficulties of the undertaking, even though it was all a part of the day's work.

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PERSONALITIES IN THE WIRELESS WORLD

MR. TSIANG TSENG-YI

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THE Director General of the Chinese Telegraph Administration, Mr. Tsiang Tseng-Yi, is a native of the Haining District of the Chekiang Province. In 1904 he acquired the third degree of Literature at the Metropolitan Examination in Peking and was appointed as Junior Clerk of the Board of Revenues. Soon afterwards by special recommendation he transferred to the Board of Communications for the purpose of dealing with telegraph matters. The Chinese Telegraphs were then administered partly by a commercial company and partly by the Provincial Viceroys and Governors. Mr. Tsiang proposed that all the commercially and provincially owned telegraph lines should be nationalised and placed under the direct control of the Board of Communications. This proposal was soon put into operation, and by 1910 the work was completed. This nationalisation of the system met with strong opposition, but Mr. Tsiang made every endeavour to overcome the difficulties in carrying out the scheme.

Since 1910 the Chinese Government has been able to extend the telephone and wireless telegraph services, devoting a part of the telegraph revenues to this purpose. In 1911 Mr. Tsiang, in the capacity of the Commissioner of Telegraphs of the Board of Communications, caused two powerful radio stations to be established, one in Peking and the other at Nanking. Not long after these had been completed the Revolution broke out, a great deal of traffic regarding military matters being exchanged by these two stations, whereupon the importance of radiotelegraphy was realised by the Chinese people, who formerly had scarcely any idea of its possibilities. Since then the wireless service has been greatly improved and extended to such localities as Shanghai, Woosung, Foochow and Canton along the coasts, and Kalgan and Wuchang in the interior.

Mr. Tsiang has been over ten years in the telegraph service, holding the important positions of Commissioner of Telegraphs of the Yuchuanpu (1910–1911); Chief of the Financial Department of Telegraphs, Posts and Navigation (1913–1916), and Chief of the Telegraph Department and Director General of Telegraphs of the Ministry of Communications (1916 onwards). He is also Chairman of the Chinese Society of Electrical Science.

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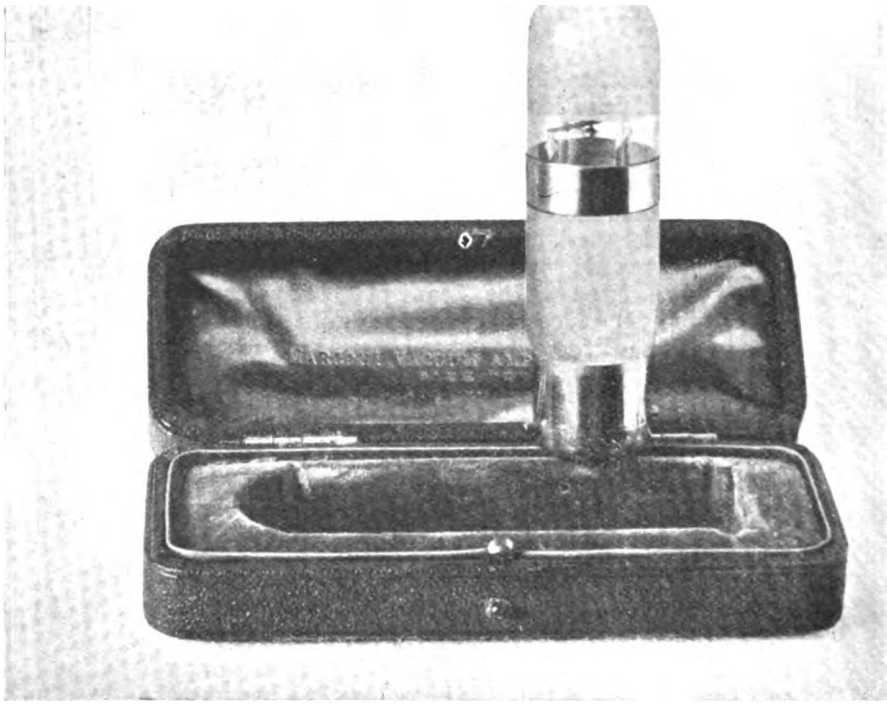

THE MARCONI VACUUM AMPERE GAUGE WITH ITS LEATHER CASE.

An Ingenious New Instrument

The Marconi Vacuum Ampere Gauge

We are able to publish this month a description and photographs of a new instrument, of highly ingenious and interesting construction, which will prove to be of great value, not only in wireless telegraphy, but in all cases where an accurate means of measuring the electric current is required. The invention in question is the vacuum ampere gauge.

The demand for a small, sensitive, robust instrument suitable for use equally on alternating and continuous current circuits is not new, and inventors have made many attempts to satisfy it. It has remained, however, for the Marconi Company to produce just what is required, and a great demand for the new gauge is anticipated.

The instrument is designed primarily as a maximum current gauge to indicate the condition of syntony in wireless circuits, and may be employed as a substitute for a thermo-junction and galvanometer combination in the measurement of wave-lengths and decrement. The principle involved is that of the bifilar suspension, one pair of the filament ends being fixed, and the other pair attached to a pivoted

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arm, the rotation of which is controlled by a spring acting against the tension of the filaments. When a current passes through the filaments, heating them and causing them to elongate, the arm takes up a new position and the angular displacement as indicated on the scale is a measurement of the current.

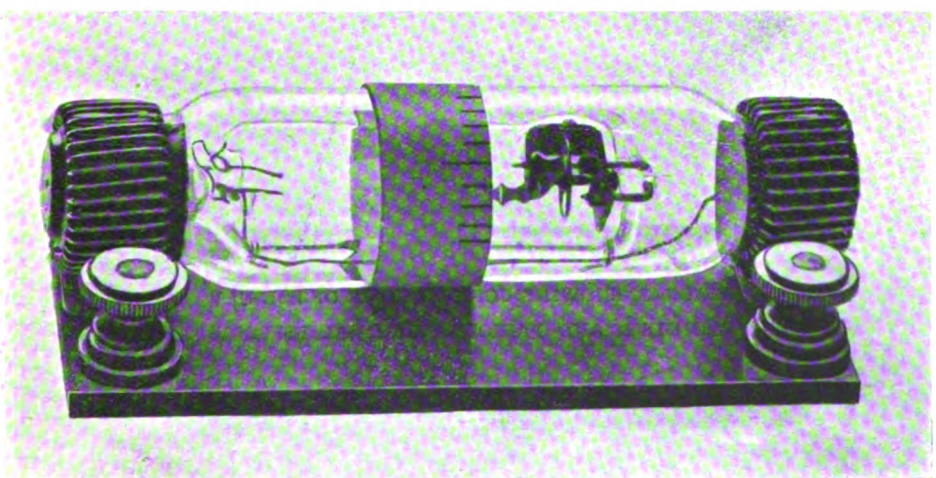
The movement is enclosed in a glass bulb exhausted of air. The sensitiveness is thus greatly increased, and the movement protected against damage and preserved from dust or corrosion.

The drawing on page 824 shows quite clearly the construction of the little instrument, which is made up in such a way as to resemble an electric lamp. In one form the bulb is attached to a brass cap with projecting pins identical with that used on standard lamp bulbs in this country, and the size of the instrument can be gauged by noticing this feature in the drawing. The screw type of lamp cap can also be supplied for use in countries where this type is standard. Other forms are capped at both ends, as shown in the photograph on this page.

The variation in zero which is characteristic of hot wire instruments in general is negligible in this type of instrument, and the natural damping renders the movement especially dead-beat.

The instrument, suitably calibrated, may also be used as a low reading voltmeter or ammeter, or as a shunted ammeter. The normal resistance of the commercial type of vacuum instrument is approximately 12 ohms. The following readings give an idea of the general characteristics of high, and normal, resistance instruments :—

No. of Inst.	Res. Cold.	Full Scale.			Half Scale.			Smallest Measurable.			Overload Test.
	Ohms.	Amps.	Volts.	Watts.	Amps.	Volts.	Watts.	Amps.	Volts.	Watts.	Amps.
6	12·4	0·11	1·44	0·158	0·065	0·77	0·05	0·02	0·22	0·0044	0·125
7	30·2	0·035	1·25	0·043	0·025	0·77	0·0192	0·007	0·17	0·0012	0·06



ANOTHER FORM OF THE AMMETER MOUNTED ON AN EBONITE BASE.

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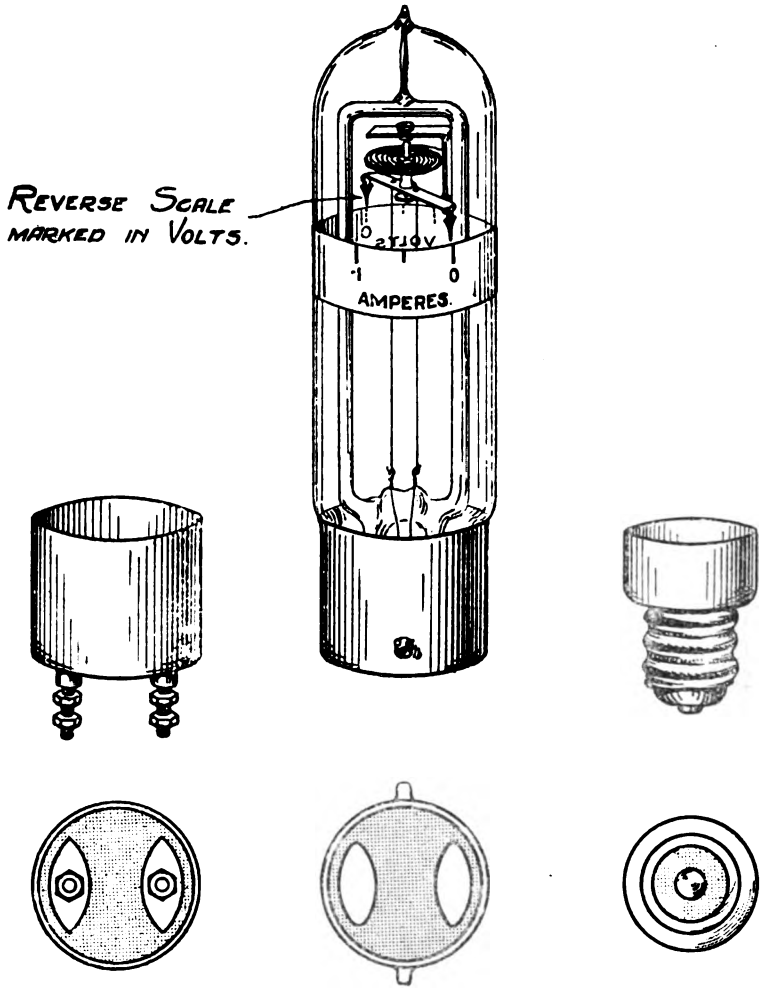

DIAGRAM SHOWING CONSTRUCTION OF THE NEW AMMETER, AND VARIOUS TERMINAL FITTINGS

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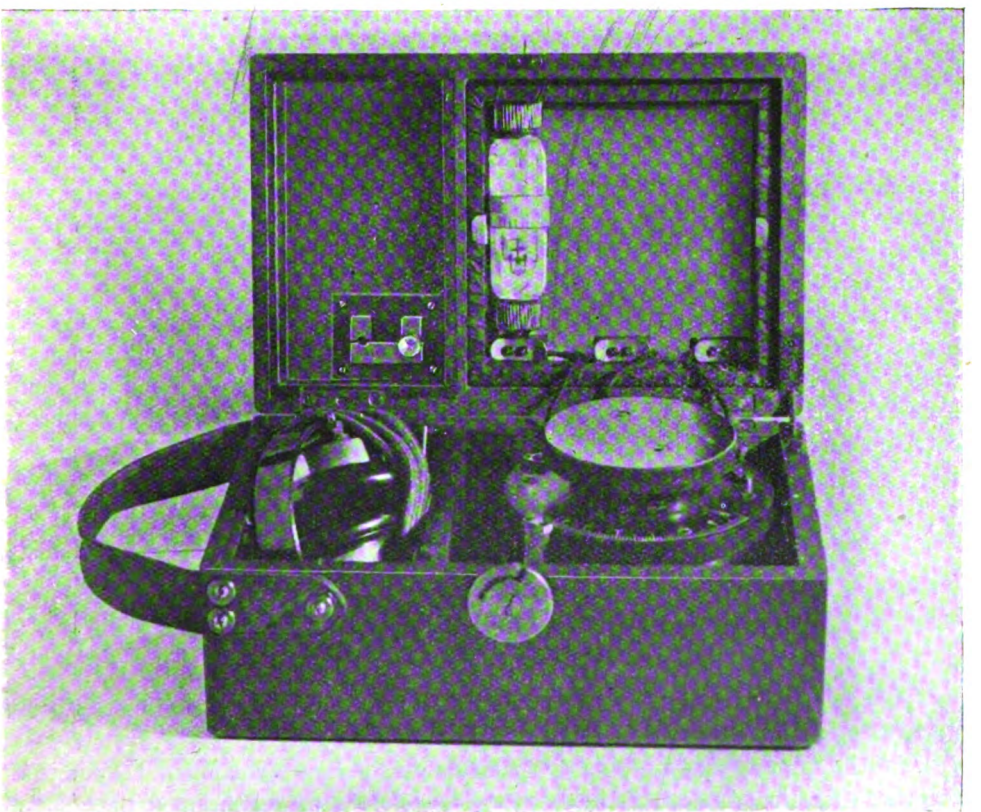
The new instrument has been greatly admired for its neat appearance, which can be well judged from the photograph on page 822 showing one of the gauges standing upright in its silk-lined case.

Enclosing the working parts in a vacuum has enabled the Marconi Company to place on the market an instrument which should prove of great general utility on account of the fact that, at a reasonable cost, it is possible to provide the means of measuring direct and alternating currents of the order of ·01 amp., without sacrificing any robustness of construction. The small size makes it a matter of no particular difficulty to insert the instrument in a circuit where no previous provision has been made for a measuring instrument. For example, as a maximum current indicator for a wavemeter, the gauge can be inserted without appreciably altering the accuracy of the calibration, as the added inductance and capacity is negligible compared with the inductance and the capacity of the wavemeter itself.

The photograph below shows clearly how conveniently the gauge can be fitted to a wavemeter, the tube in this case being of the same type as that shown on page 823.

With a wavemeter using the new vacuum gauge the wave-length of the primary circuit of a 1½-kw. set can quite easily be read when the wavemeter is held with the plane of its inductance coils parallel to that of the primary of the oscillation



THE MARCONI VACUUM AMPERE GAUGE MOUNTED IN A WAVE-METER.

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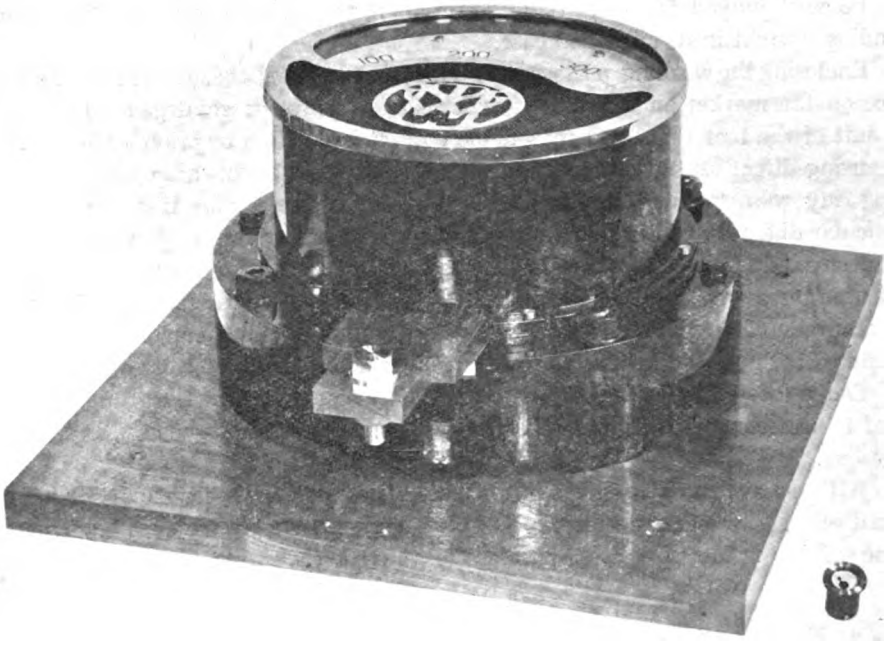

400-AMPERE TYPE MARCONI AMPERE GAUGE.

transformer at a distance of two to three feet. The noise of the spark, which often hinders the reading of a wavemeter by means of a crystal and telephones, in the case of the vacuum gauge gives no trouble, as the variable condenser has simply to be rotated until the pointer of the gauge gives the maximum reading. In this way circuits can be tuned rapidly as well as accurately.

In addition to the type of instrument already described, a range of ammeters has been designed for all capacities between 50 and 500 amperes. These instruments, while following the general design of the smaller gauges already described, differ from them considerably in detail. In the large meters the suspension filaments carry no current. The principal characteristics of this type are :—

Robust construction.
Accuracy.
Open scale at mid-position of pointer.
Zero error practically nil.
Watt loss about a third of that usually in commercial instruments of the same capacity.
Movement absolutely dead-beat.

A type of vacuum instrument for direct insertion in the aerial circuit is being developed, and we hope to publish a description in due course.

On this page we show a photograph of one of the large 400-ampere instruments, together with the smallest of the range. The photograph on the next page shows the cover removed and gives some indication of the general construction.

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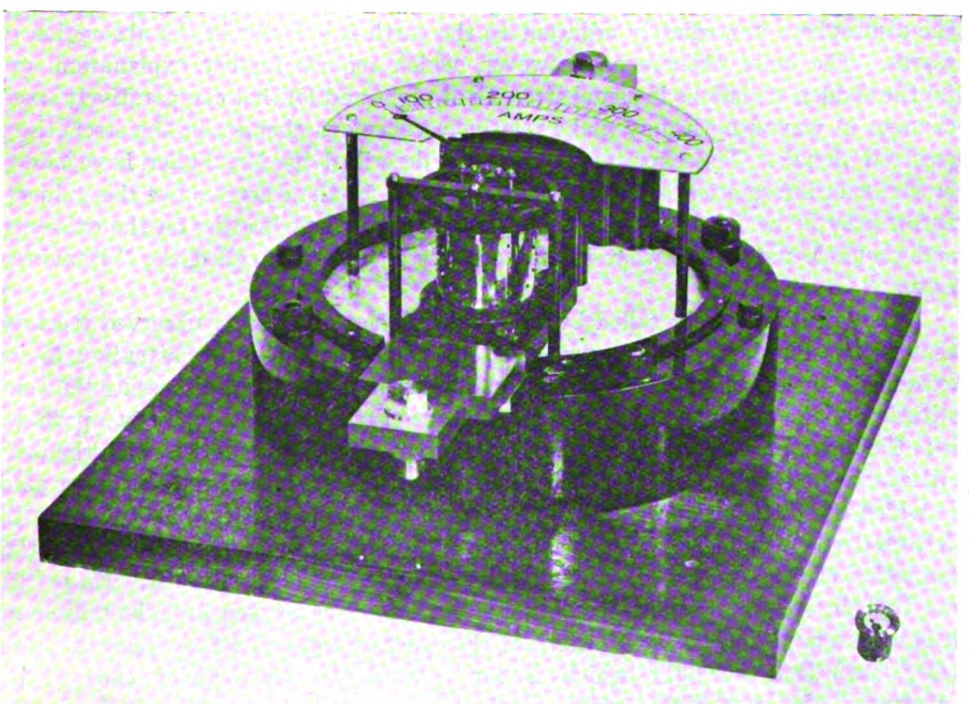
Readers who are acquainted with practical wireless work will realise that the two types of instruments described above are likely to prove of the greatest service, not only in radiotelegraphy, but in all practical application of electricity.

Some Wireless Speed Records

ALTHOUGH the service of the Marconi Wireless Telegraph Company of America between the United States and Japan was inaugurated only a short time ago, several speed records in sending and receiving messages have already been made by operators in the transpacific stations.

Operator " Paddy " Walsh, of Honolulu, recently sent to the Marconi receiving station in California, a distance of 2,372 miles, sixty-seven messages in one hour and twenty minutes. None of the messages was shorter than fifteen words, and some of them contained forty words. W. H. Barsby, operator at the receiving station, copied the messages without a break or an error.

Operators in the Marconi office in the heart of the business section of Honolulu are now, with the aid of repeaters, transmitting direct to both the United States and Japan. Automatic transmission and reception of messages at a speed of from 80 to 100 words a minute will be brought into use in the near future. Duplex transmission equipment has been provided, the tests made, and, when conditions warrant the step, transmission at that speed in two directions simultaneously will be employed.



400-AMPERE TYPE WITH COVER REMOVED.

(See opposite page.)

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Digest of Wireless Literature

The Heaviside Layer.

In an interesting and informative paper contributed to the Proceedings of the Institute of Radio Engineers, Professor E. W. Marchant of the University of Liverpool dealt with the Heaviside Layer, and discussed to what extent this layer can explain the phenomena described by Mr. Fuller in a paper previously read before the American Institute of Electrical Engineers. It is within the knowledge of all radio operators, said Professor Marchant, that signals vary widely in strength, often in the course of a few minutes ; and such variations can most easily be explained by reflection and refraction from moving masses of "cloud" or ionic fog. The surface wave theory developed by Sommerfield, while explaining transmission over long distances, round the curvature of the earth, does not explain these sudden changes. The fact that these changes occur more by night than by day provides further evidence that the reflection and refraction theory of which Dr. Eccles has been, in this country, the chief exponent, is the most likely one to explain observed phenomena.

The experiments described by Balsillie in which he found that dust storms occurring along the line of transmission affect signal strength, when the transmission is in the direction in which the wind is blowing, are of interest, as they indicate that the atmosphere immediately adjacent to the earth is a factor in the absorption of waves. The chief phenomena, however, which require further explanation are (*a*) the sudden variations in signal strength at night and (*b*) that comparatively small changes in wave-length may make relatively enormous changes in the strength of received signals. The experiments recently described by Mr. Fuller have added much exact information to that already available for the discussion of this subject, and it may be useful, therefore, to consider them in their bearing on the existence and probable nature of what in this country is generally called the "Heaviside Layer."

Though it is usually called by this name, Professor Fleming observed recently that it was Sir James Dewar who was one of the first to draw attention to its existence. In a lecture to the Royal Institution in 1902, when discussing the constitution of the atmosphere, Dewar pointed out that there were really two parts to it : the lower part in which atmospheric currents circulated, and in which the constituents were similar to those of the atmosphere at lower levels, and the upper part in which the distribution of gases was governed by their density. In two lectures delivered recently to the Royal Institution Professor Fleming has discussed the formation of this upper ionized layer and the causes which produce it. He points out that, in order to produce ionization in such a gas as oxygen by light radiation, it is necessary to have a wave length of the order of 1,500 to 1,800 angstrom units (10^{-7} mm.) that is, light which is far beyond the ultra violet end of the spectrum. If such light really produces any ionization, then it is to be expected that the ionization would be reduced at night, and therefore that signals might be expected to vary in strength at night if these ionized gases are

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the causes of signal variation. Professor Fleming suggests, however, that at heights of the order of 60 miles (100 km.), where the ordinary constituents of the atmosphere disappear and are replaced by hydrogen and helium and possibly other lighter gases, the most likely agency in producing ionization is the solar dust projected from the sun and transmitted to the earth through the agency of the pressure of light. This explanation of the production of an upper ionized layer of gas is verified by the fact that the time interval elapsing between the passage of a sun spot across the solar meridian and the corresponding magnetic storm as shown by Arrhenius is about 45 hours, a figure which agrees fairly closely with the time Professor Fleming calculates that a particle of 1,200 angstrom units diameter would take to pass from the sun to the earth. Whatever the cause which produces this layer, there is little doubt that such a layer exists, not necessarily in the form of a shell concentric with the earth, with fairly flat surfaces, but more likely in the form of large masses of gases in the upper regions of the atmosphere which act as reflectors and refractors for the waves that are used for the transmission of radio signals.

Other facts bearing on the presence of this layer have been dealt with by Dr. Eccles in a paper published by the Royal Society. It will not be necessary to reproduce the argument he uses to prove its existence; that may be assumed. It is the object of this paper to discuss to what extent the Heaviside Layer can explain the phenomena described by Mr. Fuller.

Dr. Marchant then went on to discuss the relation of Heaviside Layer to the phenomena described by Mr. Fuller.

* * * * * *

THE STUDY OF PURE SCIENCE.

In an illuminating address on Science and Industry, with Special Reference to the Work of the National Physical Laboratory, delivered to the Birmingham and Midland Institute, Dr. R. T. Glazebrook, the Director of the National Physical Laboratory, laid special emphasis upon the importance of research work in pure science. "Let us note then, in the first place," said Dr. Glazebrook, "we must have "scientific knowledge. That point I need not labour, but note also that to be "successful that knowledge must be pursued for its own sake. Each of the modern "practical applications of science had its foundations in purely scientific work, and "to quote Professor Gregory in his recent book discovery or the spirit and service "of science was not the result of deliberate intention to make something of service "to humanity. It is hardly necessary to illustrate this; let me, however, give one "classical example. The discovery of the laws of electromagnetic induction is due "to Faraday, and is described in his first three series of 'Experimental Researches,' "published in 1831–33. Oersted, Ampère and Arago had investigated some of the "phenomena connected with the magnetic force produced by an electric current, "and to Faraday it appeared clear that conversely it should be possible to produce "electricity from magnetism, as he put it. It is difficult to picture the world to-day "without electric power, and yet the whole development of electrical machinery, "as we know it, rests on the laws described in these brief scientific papers. Each "advance of knowledge brings its benefits to mankind, and in a general way Faraday "may have hoped to be a benefactor to his race by widening the sphere of knowledge,

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" but it was the desire to know the truth which led him on and to which we owe such tremendous consequences.

" We must have the student of pure research, the genius who goes on his way " discovering new truths, irrespective of consequences, laying bare more and more of " nature's secrets and unravelling her mysteries.

" In England we have never lacked such men, our roll of great discoverers has " been a glorious one. Too frequently their lives have been hard and difficult, " prophets without honour they have lived ; to-night it is not my task to speak of " them beyond urging the importance of giving every encouragement to such men by " supporting in the most generous spirit any among you here in your University or " elsewhere who are advancing the bounds of knowledge, searching for truth in some " of its difficult byways. The endowment of pure science is essential ; without it " the attempt to apply science to industry fails."

* * * * * *

WIRELESS IN TRANSMISSION NETWORKS.

Communication between generating plants and sub-stations constituting a power distribution system is an essential for satisfactory operation. Moreover, the communication apparatus must give immediate and reliable service. Line telephones have been largely used for this purpose, and, when proper precautions against inductive interference are taken, give good results so long as the telephone wires remain in position. When the wires come down, however, the system becomes helpless, station engineers consequently grow nervous whenever winds are high or sleet storms appear. Several progressive power transmission men are now applying the radio systems to their own peculiar problems with notable success. Since the only structures which can be affected by storms are at the operating stations themselves, maintenance labour is localised and possible interruptions may be speedily ended. In installing wireless for emergency or regular service it must be borne in mind that first cost is a relatively unimportant item. The purpose of the service is to furnish insurance ; consequently, if it is to be effective, the plants must be so chosen that they can supply uniformly satisfactory communication at all times. It will not do to " save " by installing inferior apparatus or stations too small to signal reliably over the required distances. Radiotelegraphy is finding new commercial uses almost daily, and the indications are that in its application to power station communication both the wireless and the transmission engineers will make material gains.—*Electrical World.*

* * * * * *

CABLE VERSUS WIRELESS.

Our contemporary, the *Telegraph and Telephone Age*, has been asked if in their opinion the wireless will ever supersede the cable. Dealing with the matter, the editor quotes a cable authority as stating: "The wireless will never supplant the " submarine cable as many people think." It must be borne in mind, says our contemporary, that the cable is a service connecting two points. The wireless is a universal service. It can reach the remotest points on the earth. The service that the wireless is doing for humanity alone, irrespective of its value in handling commercial business, is beyond estimate. The wireless reaches places where cable

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service is impossible. In some cases wireless has taken the place of the cable, Nassau, Bahamas, being an instance, the cable connecting that island being abandoned in favour of the wireless.

A wireless authority says :

" Several important technical problems in connection with long distance wireless " telegraphy still await solution, but the development of the art during the past few " years makes it altogether conservative to state that these problems are fast being " solved and that the most serious obstruction to perfect long distance wireless " communication, *i.e.*,' Static,' will most probably be removed in the quite immediate " future.

" I think the answer to the question, therefore, is most positively in the affirma- " tive. To my mind the wireless will eventually supersede the cable because it is " natural and logical that it should do so. The only function that a cable performs " is to conduct electrical energy. When a natural medium exists for doing the " same thing, *i.e.*, conduct electrical energy, is it not superfluous to provide an " artificial means for doing the same thing, namely, laying a cable ?

" If nature provided a good road between New York and San Francisco, and we " wished to travel over this road, the only cause there could be for building another " road on the top of it in the form of an elevated structure would be when the natural " road was unable to handle all of the traffic. In transocean communication the " same will be true of the ether and cable roads.

" Moreover, with the advance of science, I am convinced that we shall eventually " be able to communicate across the Atlantic or across the Pacific with the use of " moderate power. By moderate I mean twenty-five to fifty kilowatts in the " antenna. When this is accomplished the cost of long distance wireless stations " will be insignificant as compared with the cost of laying the cables."

Indispensability

THE fact that wireless apparatus ought to form as essential a feature of sea-going vessels as life-boats, or any other part of their regular equipment, is being rapidly recognised in all quarters.

A short while ago, at an inquest held on Mr. Wm. Donaldson, the master of a merchant vessel, which was sunk with the loss of 17 hands, the jury requested the coroner to write to the authorities suggesting the advisability of installing wireless on all ocean-going vessels with the least possible delay. Towards the close of last year His Majesty's Government issued a proclamation in the *London Gazette*, announcing immediate steps for the compulsory fitting of radio apparatus on vessels of 3,000 tons and over ; the French Government almost immediately followed suit, whilst a recent regulation was issued by the Italian Government insisting on the fitting of wireless on all vessels carrying 50 or more persons on board.

The recommendation of the coroner's jury above referred to appears to indicate that wireless indispensability is being brought home to private citizens ; whilst the legislation enacted by one Government after another to enforce universal radio installation on sea-going vessels seems to show that official authorities have been as effectually impressed.

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Wireless in Polar Exploration

THE interesting photograph, which we reproduce on the opposite page, shows Sir Ernest Shackleton's famous ship, the *Endurance*, in the process of sinking beneath the ice. The main and mizzen masts are smashed off at the level of the deck. The foremast is broken at the cross-trees and one mast with the sail still lashed on stands upright in the centre of the view. The hull has passed out of sight, and dogs and men can only watch the inevitable further stages of the ship's destruction. It should be explained that first the vessel was crushed by colliding pressures and then sank for a certain distance between the ice floes. Next, the floes coming together again, sheared off the masts and top deck and thrust the ship below the ice into the waters of the Weddell Sea.

How the vessel appeared before she met with disaster can be excellently judged from the photograph we reproduce on page 380 of our issue for September, 1915. In that issue will also be found some notes regarding the wireless installation and the arrangements which had been made to utilise it.

An Erroneous Report

EARLY in December last a telegram from Rome was published in a number of newspapers to the effect that Countess Helena Gleichen, of London, and Miss Nina Hollings, directresses of the British Wireless Telegraph Section, had been awarded the bronze medal. The announcement was couched in the following identical terms as regards both ladies :—" The Lady Directress of the British Wireless Telegraph " Section gave her useful and valuable work for wounded Italians on the Isonzo " front, hastening wherever she was summoned, even through zones bombarded by " artillery. On several occasions she was the object of enemy fire and showed " courage, intrepidity and contempt of peril, always fulfilling her part with zeal, " self-sacrifice and a deep feeling of philanthropy."

THE WIRELESS WORLD immediately caused enquiries to be made at the Italian War Office, and the following reply has now been received :—

" We beg to inform you that Countess Helena Gleichen and Mrs. Hollings are " members of the *Radiologic* section of the British Red Cross in our Army. Said " Radiologic section, which was a present of Countess Gleichen herself, is constituted " of an ambulance with Radiologic apparatus and of several automobiles for the " transportation of the staff, and is exclusively a unit of sanitary character. We " believe that the news reported by the English press has been taken from Bulletin " of Rewards No. 106 where has been printed in error that the two above-mentioned " ladies to whom has been awarded the Bronze Medal were Directresses of the " British Wireless Telegraph Section."

Although the two ladies in question have nothing to do with wireless telegraphy, they are doing a magnificent work, and we are sure our readers will be glad to hear of the Italian Government's award.

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THE S.S. "ENDURANCE" SINKING IN THE ICE.

Photographed by Frank Hurley.

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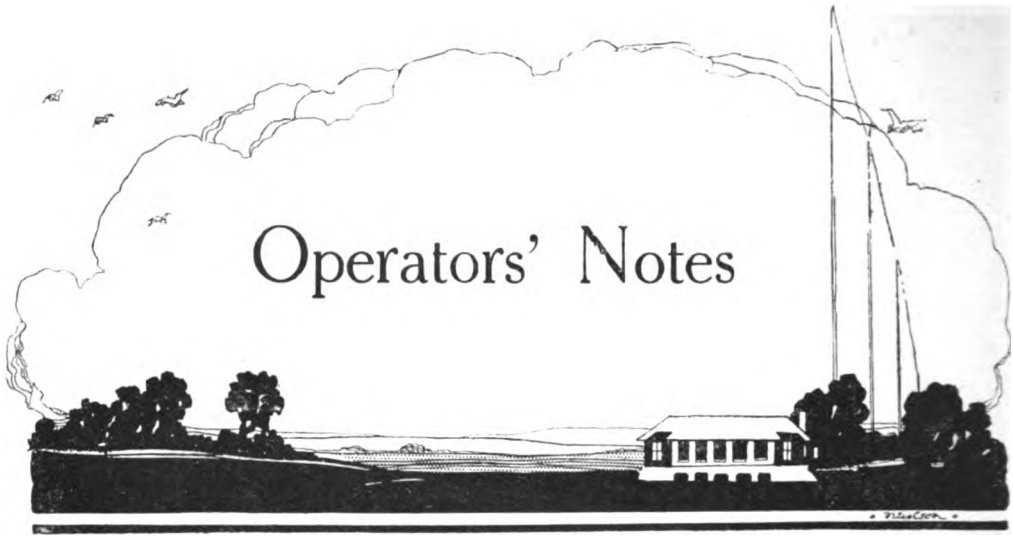

Some Notes on the Maintenance of Accumulators (II.)

By WILLIAM PLATT.

THE auxiliary resistance previously mentioned is connected in circuit by means of a two-way two-pole tumbler switch. When the switch is in charging position the resistance is connected in parallel with the lamps on marine switchboard. With the switch in discharge position the resistance is connected in series or directly across the accumulators, therefore when discharging cells through this resistance the rate of discharge is from 8 to 9 amperes.

DEVELOPMENT OF ACCUMULATORS.

The first accumulator was invented about the year 1801, but it was not until 1860 that Planté produced a practical cell. This was of remarkable efficiency compared with those produced by other experimenters who had endeavoured to develop a means of storing electrical energy. Planté's process consists of taking two lead plates, coiled closely round each other, but not touching at any point, and placing them in a solution composed of sulphuric acid and water. The outer ends of the plates are connected to a source of electrical supply and the cell then charged and discharged. A second charge is now given, but in the opposite direction, the cycle of charges being continued until the plates become possessed of a high degree of porosity. This process is spoken of as forming.

When the forming process is ended and the plates discharged there is a layer of active material on each plate. This active material can be regarded as $PbSO_4$, or lead sulphate, and we may show the result symbolically as follows :

	Positive Plate.	*Electrolyte.*	*Negative Plate.*
Discharged—	Lead sulphate	Water	Lead sulphate
	$PbSO_4$	$2H_2O$	$PbSO_4$

When the accumulator is charged the action that takes place is the dissociation of the lead sulphate and water molecules and a reunion of components, with the

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result that when the cell is fully charged the condition of the plates has changed as follows :

	Positive Plate.	*Electrolyte.*	*Negative Plate.*
Charged—	PbO_2	$2H_2SO_4$	Pb
	Lead peroxide	Sulphuric acid	Spongy lead

The positive plate is now a dark brown colour and the negative grey. In practice it would not be permissible to discharge a cell until the electrolyte is reduced to pure water as shown above, as this would result in the plates becoming coated with a layer of insoluble sulphate, Pb_2SO_4. (It may be mentioned here that there are two forms of lead sulphate, one soluble and the other insoluble. The latter is most injurious to the cell.) This will be explained later under the heading " Care of Cells." The process of forming accumulator plates is a long and tedious one, and in its place some manufacturers adopt the methods that were first used by Faure. His procedure consisted in making up lead grids containing a percentage of antimony, the latter being used for hardening and strengthening the lead. These grids were filled with a paste made up of lead and sulphuric acid, and by this means a greater depth of active material was obtained than by Planté's electro-chemical method, and the lengthy " forming " period considerably curtailed. Some manufacturers use both methods, the plates being first pasted and then formed by the electro-chemical process.

RATING OF ACCUMULATORS.

The ampere-hour capacity of an accumulator—*i.e.*, the number of hours at which it can be discharged at the rate of one ampere per hour—is governed in the first instance by the exposed area of the positive plates. The greater this area, the greater is the amount of active material which can be formed during the period of charging, and the greater the quantity of electro-chemical energy " stored." It is therefore correct to assume that there is a direct ratio between ampere-hour capacity and the superficial area of the positive plates. On the average a cell should give 5·75 to 6 amperes for each square foot of positive plate surface. There is also a fairly definite relation between the weight of both positive and negative plates combined and the ampere hour capacity of the accumulator, and this relation usually works out to about 4 amperes to each lb. weight. Manufacturers always fix the normal rates for charging and discharging, but if the ampere-hour capacity is known these rates can easily be calculated. Usually makers aim at producing cells which will perform 8 to 9 hours' work at the normal rate of discharge.

Suppose the combined weights in pounds of positive and negative groups of a cell to be 20, this figure should be multiplied by four to obtain the ampere-hour capacity. This gives 80, which, divided by eight (the number of hours at which a cell will usually work on a normal discharge) gives 10 ; therefore 10 amperes could be fixed as the normal rate of charging and discharging without damage to the cells. It is possible, and some manufacturers permit in their instructions, to discharge cells at rates much higher than the normal, but it is not to be recommended, as the ratio of output to input decreases rapidly in such cases, and the life of the cell is shortened. In general, provided a correspondingly low rate of charging is

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fixed, the lower the discharging rate the longer will be the life of an accumulator. The ratio of output to input should be as 10 to 11.

ELECTROLYTE.

What is known as accumulator acid should always be used. It is manufactured from Sicilian brimstone by the "lead chamber" process, and usually contains a small percentage of lead, but if this is not in excess it does no harm to the plates. Some acid is manufactured from iron pyrites by what is known as the contact process. This depends upon the principle of formation of sulphur trioxide when a mixture of sulphur dioxide and air is passed over heated platinised asbestos. Acid manufactured from iron pyrites frequently contains iron, which is most harmful to the plates. Pure acid can readily be distinguished from commercial acid by its appearance, the former being a heavy colourless oily liquid while the latter is a trifle brownish in appearance.

When mixing acid for accumulators care should be taken to use only a clean porcelain or glass container. Distilled water should first be poured into the container and the acid then slowly added. The water should never be added to the acid as the sudden heat generated by such an action would probably crack the container, and boiling acid would be thrown into the face of the person making the mixture. The specific gravity of accumulator acid is usually 1·215, and it will be found that approximately one part of pure acid to four of water is required to obtain such a solution. Acid has a strong corroding effect on the skin, and, if pure, is likely to cause a painful wound. It is also injurious to linen, cloth, etc., and a quantity of diluted ammonia or lime water should be kept handy to apply in case of splashing the hands or clothes, these solutions being very effective in neutralising the acid. Ammonia must not be allowed to get into the accumulators as it would injure them.

There is a direct ratio between the specific gravity of the electrolyte of an accumulator and the ampère-hour capacity, and readings of the specific gravity should therefore be frequently taken.

Erratum

IN the article by Lieutenant Bertram Hoyle, entitled "The Accurate Calculation of Inductance," which appeared in our December issue, an error crept in, which, although obvious to anyone using the table, should, we think, be pointed out. In the tabulated values for $\frac{d}{D}$ obviously $\frac{d}{D}$ cannot be greater than unity. The table should therefore run :-

$$\left.\begin{matrix}1.00\\0.99\\0.98\end{matrix}\right\} \text{ instead of } \left\{\begin{matrix}1.00\\1.99\\1.98\end{matrix}\right.$$

as printed.

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Messages by Wire

The Telegraph Methods of the British Post Office

MR. HERBERT'S book *—the standard work on the telegraph system of the British Post Office—is so well known and widely esteemed that any word of praise from us would be superfluous. The third edition, just to hand, brings the volume thoroughly up to date, and, as would be imagined from the progress which has been made since the book last appeared, the additions and alterations have been considerable. Nearly 1,000 pages with 630 illustrations now go to make up this comprehensive treatise, which is as clearly written and illustrated as could be desired.

Very wisely the author opens the book with an Introduction detailing the fundamental principles of magnetism and electricity, and treating Ohm's law and the electrical units in a careful manner. Chapter I. deals with primary cells, extensively used in the Post Office as a source of current. It may be remarked that, as the result of Mr. J. G. Lucas's researches, his modified Leclanché cell has now replaced all other forms of primary wet cells in the Post Office Telegraph Service. Accordingly we are not surprised to find that much of the matter in the previous editions relating to Daniell and other cells has been deleted. The popular "dry cell," now so useful to the general public in the millions of pocket flash-lamps, is clearly explained, and a tabulated comparison of cells of various types makes interesting reading.

Chapter II. is of great importance, being devoted to the calculations in connection with circuits and conductors. This chapter is subdivided into four parts, the first dealing with the Arrangement of Cells, the second with Joint Resistance and Division of Current, the third with the Resistance of Wires of Varying Dimensions, and the fourth with Electro-Magnets. Unlike many technical writers, Mr. Herbert has not given much place to mathematics, for he says: "After anxious "and careful consideration in the light of an extensive teaching experience, I have "deemed it best to avoid the use of mathematics, and I am satisfied that the more "elementary method adopted will make the work accessible to the far larger and "wider circle of readers who most need the information I have sought to convey."

In the third chapter we come to the Measurement of Current, the many forms of galvanometer in use being fully described. Students of electricity will find the pages devoted to the Tangent Galvanometer of particular value, the great merit of this instrument lying in the fact that its indications bear a definite and simple relation to the current flowing through its coils, the current being directly proportional to the tangent of the angle of deflection.

In further chapters measurement of E.M.F., battery testing, and the measurement of resistance are considered. In Chapter VI. the author deals with single current systems and relays, and here we find descriptions of the various types of sounder and single-current keys, which are used in this form of telegraphy. Nothing could be clearer to the student than Mr. Herbert's descriptions in this chapter. They are indeed typical of the clear and lucid style of the whole book.

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* *Telegraphy.* By T. E. Herbert, A.M.I.E.E. London: Whittaker and Co. 9s. net.

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Capacity, condensers and double-current sounder are next described. The double-current system has several advantages over the single-current, greater speed of working being the most prominent. The subsequent chapter is given up to the Differential Duplex Telegraph, and is immediately followed by a clear description of the quadruplex. Quadruplex working consists in the simultaneous transmission of two messages in each direction over a single wire connecting two stations. It is accomplished by taking advantage of the fact that currents may differ from each other in direction and strength.

Automatic systems of telegraphy take a prominent place in the Post Office system, and enable enormous quantities of traffic to be handled in a minimum of time. The generic term " automatic system " is usually employed to denote all the systems in which the signals are transmitted by mechanical means as opposed to those in which the signals are sent by a manually operated key. The speed at which most circuits can be worked by a machine transmitter is far greater than that at which even the most highly expert telegraphist can operate a key. Further, the speed is constantly maintained and the signals are more accurately formed than is possible with hand-working.

The Wheatstone automatic system, which is described in Chapter X., is that most widely used. The apparatus comprises three separate and distinct parts. Firstly, the perforator, which is employed to prepare the tape (known professionally as " slip ") controlling the signals sent out. Secondly, the transmitter, which sends out the signals in accordance with the perforations on the slip. Thirdly, the receiver, which is a very sensitive form of polarised direct writer. The perforation of the slip can be carried out in many ways, the simplest consisting of passing the unperforated tape through the Wheatstone perforator, which is purely mechanical in action. It consists of five steel punches operated in suitable combination by three keys, one of which gives dots, another dashes, and the third spacing. In the ordinary form of Wheatstone perforator, the operator himself provides the power to punch the holes, but pneumatic devices are also in use, and enable from one to eight slips to be simultaneously punched, a tap on the keys releasing compressed air, which forces the punches through the paper.

One of the most interesting sections of the book is that devoted to the various types of perforators, several of which operate with a keyboard resembling that of a typewriter. In one form of Wheatstone receiver, the received signals operate a second perforator, which punches tape identical with that passing through the machine at the transmitting end. This second perforating slip is then run through a machine device which translates the dots and dashes into a clear typewritten message. It will be seen that in this way it is possible to transmit and receive messages without any knowledge whatever of the Morse code.

Space will not permit us to deal at any length with the remaining sections of the book, which covers various forms of printing telegraph, central battery systems, repeaters, testing devices, and many other equally importnat matters. The chapter on Secondary Cells, however, is worthy of special mention, the description of various types of accumulators being very clear and to the point. Chapters are also devoted to the consideration of Aerial Lines and Underground Lines respectively, this part of the work of the Post Office calling for special care and ingenuity. A word must

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also be given to the ten appendices, the first of which is devoted to the Molecular Theory of Magnetism, and others to Notes on Chemistry, The Siemen's High-Speed Automatic Printing Telegraph, and Superposing. Appendix G. consists of syllabuses of examinations set by the Post Office and the City and Guilds of London Institute.

Although the volume claims to be " a detailed exposition of the telegraph system " of the British Post Office," we do not find even a passing mention of radiotelegraphy, which certainly forms a part of this great organisation. This is more noticeable in that among the subjects dealt with in the examinations above referred to wireless telegraphy finds a place. Perhaps this omission will be remedied in a future edition.

Altogether the volume is excellent, and should be in the hands of all who desire to have an intelligent knowledge of the working of the telegraph system of the British Isles.

" Wireless in Jungleland "

An Insect which Eats through Lead

OUR article in the November issue entitled " Wireless *versus* Wire in Jungleland " has evidently aroused considerable interest, particularly amongst people who had previously entertained the impression that, once two places have been linked by a wire, uninterrupted telegraphic communication is assured. By way of further illustration of the disillusionment on this point, as set forth in the article referred to, we may say that our attention has been recently drawn to a further little animal pest, known as the " Cable-eating Bug." We extract the description thereof from our contemporary the *Telegraph and Telephone Age* :—

" The bug, which is so fond of eating the lead-sheathing of cables, has won " international fame with a pyrotechnic suddenness ! His methods of prosecuting " the business for which he was born have only recently been discovered. It appears " that he bores through the lead-sheathing of a cable by scraping the surface until " a small indentation has been made. Into this he inserts his teeth, and then starts " rocking his head from side to side while exerting all possible pressure downward.

" Up to the present, as far as the United States are concerned, the cases of " cable trouble which have been traced and found chargeable to the activities of " metal-destroying bugs are those reported from California and the southern States. " It is quite possible, however, that in other sections of the country cases of trouble " heretofore attributed to lightning discharges may in reality have been due to the " depredations of members of one or other of these highly interesting bug families."

Doubtless the universal use of wireless in the above-mentioned districts would result in the extermination of these " interesting specimens."

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Administrative Notes

FRENCH WEST AFRICA.

THE coast station of Tabou, French West Africa, has now resumed working.

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ITALY.

The *Gazzetta Ufficiale* contains the text of a Decree (No. 1,587) relative to wireless installations on board merchant ships. Merchant vessels carrying 50 or more persons on board must, unless they are specially exempted, be provided with radiotelegraphic installations.

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JAPAN.

By letter of October 14th the Japanese Administration has informed the International Telegraphic Bureau that under date of October 9th His Excellency Baron Kenjiro Den has been named Minister of Communications, in the place of His Excellency M. Katsuto Minoura, who takes his resignation from the same date.

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LIBERIA (REPUBLIC OF).

The coast station of Monrovia (F.M.A.) has suspended working.

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PERU.

A wireless station has been erected at Cachendo, situated in Peru between Mollendo and Arequipa. The following particulars of the station have been received :

Name of Station.	Call Letters.	Wave Length (metres).	Approximate Range.	Service.	Hours of Service.
Cachendo	O A B	600, 3,500	Day, 600 Night, 1,800	Public	First 15 minutes of each hour

Coast Station Tax—*14 centavos per word.*—This coast tax is applicable to radio-telegrams worded in plain Spanish language ; for radio-telegrams in code, or worded in a language other than Spanish, the coast tax is doubled.

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PORTUGAL.

By telegram of November 1st the Portuguese Administration has informed the International Bureau that the legal time used previous to June 18th, 1916, is re-established in Portugal (Continental).

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TASMANIA.

By telegram of October 5th the Australian Administration has notified the Bureau that mean time in Tasmania is advanced by one hour from 2 o'clock on the first Sunday in October of each year till 2 o'clock on the last Sunday of March of the following year.

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Wireless Telegraphy In the War

"Codes of Honour" Violated.

In the early days of man, when—as Andrew Lang puts it in one of his most charming poems—

Man had no tact,
And could ne'er take a hint,
Whilst his notions he backed
With a hatchet of flint—

we may suppose the ancient proverb about "all being fair in love and war" to have been absolutely exact. But, in the many thousand years which have elapsed since those days, codes of honour have arisen which have tended to mitigate man's savagery, even when—as in war—an appeal is being made to the elemental passions. It constitutes one of the most saddening circumstances surrounding the present struggle that our German foe have deliberately set at naught these long-established codes of honour in war-time.

On various previous occasions we have made references to "wireless traps," such as attempts on the part of the captains of German war vessels to lure British transports and other vessels from the course appointed for them by radiating faked messages, which purported to emanate from friendly sources. Such a procedure would appear to be one of those *ruses de guerre* held traditionally to be perfectly permissible. But some of the more recent manifestations of German warship radio-activity stand upon a different plane altogether. For instance, in the earlier days of January a Dutch captain, on his return to Amsterdam from a long sea voyage, informed one of our Netherland contemporaries that, whilst he was in the Bay of Biscay, he received the wireless signal S O S, proceeded immediately to the spot indicated, *as in duty bound under International Regulations*, and found the signal to have originated with a German submarine, not in the least need of assistance. So far from displaying any shame for such conduct, the German submarine commander merely expressed his disappointment that the vessel which answered the call of humanity flew the Dutch, and not the British, flag. Now such a procedure is, if anything, worse than the conduct of infantry who lure an enemy into ambush by the display of a white flag. The London International Convention of 1912, ratified

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by Germany and issued in common with all the important Powers of the world, lays it down that signals of distress shall have priority over all others, and that it shall be the duty of every person receiving them immediately to take action to render the assistance called for.

Again, on the occasion of the sinking of the great hospital ship *Britannic*, to which we referred in our last issue ; according to one of the published accounts, we learn that wireless messages were received by vessels proceeding to the rescue, stating that no assistance was required. The source of this message has apparently not been ascertained with certainty ; but it is legitimate inference that the message came from enemy and not friendly aerials ; indeed, such conduct fits in only too well with the general trend of Teutonic conduct. The morality of the procedure needs no comment from us, and we are of the opinion that no more suitable epithet than " saddening " could be found for characterising such conduct on the part of enemies whose courage and skill might otherwise have aroused within us " the stern joy which warriors feel in foemen worthy of their steel."

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MISSED OPPORTUNITIES.

One very excellent way of learning what one owes to a certain instrument is to do without it for a while. We get a good insight into the utility of aeroplane wireless from an account recently sent home by a newspaper correspondent. It is concerned

Photo : Topical.

THE FRENCH DIRECTOR OF MILITARY TELEGRAPHS IN HIS MOTOR-CAR ON A TOUR OF INSPECTION.

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Photo: Topical.

FRENCH MILITARY WIRELESS SETS IN MOTOR-CARS.

with the adventures of a subaltern in the Flying Corps who was serving in Mesopotamia at a time when he was "monarch of all he surveyed" (*i.e.*, when his was the only plane available). He was scouting on a machine unfitted with radio apparatus, and—as soon as he went up—noticed how at a certain height he ceased to be troubled by the shimmering mirage which in hot climates confuses the human eye and judgment of distance so long as the observer is located on the earth level. From his vantage point in the sky everything was "clear as a bell."

> Yonder go our cavalry and the enemy's, nearing each other in the haze totally unawares! . . . What's ——'s brigade wheeling round for now? A mile further advance would turn the enemy's flank. . . . The Turks are leaving their front trenches; they're fully 3,000 strong: oh, if only I could get our gunners to shell them from across the river. . . . Now's the time; if only the cavalry would go for them! . . . What a chance they've missed!

Matters have been amended now, and the British air ascendancy in Mesopotamia is at present as complete as it is in France. The machines are of the latest pattern, and aeroplane wireless keeps the pilots and observers in the sky in close touch with the artillery commanders and army leaders beneath them. The erection of hangars has reduced the wastage of aircraft by giving protection against the alternate sun-baking and rain-drenching to which the machines were subjected in the earlier stages of the campaign.

The scraps of the flying man's remarks, from which we have just quoted, speak eloquently of missed opportunities which would not have been let slip had wireless

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been available. And may not this position of the hovering observer, chafing at being unable to communicate with his comrades below, give us some hint as to what perchance is happening in an unseen world? May it not be that those who have "passed over," crossing the "bourne from which no traveller returns," look down upon the scene below, unaffected by the mirage of earthly bonds, and longing for some means of communication whereby they may radiate timely warnings of "lost opportunities" to their loved ones still battling in this world of sense?

* * * * * *

WIRELESS DRAMA.

MR. ALFRED NOYES has been recently contributing to the Press a number of graphically written descriptions of matters at sea. Any of our readers who may have missed them would do well to turn up the accounts in the back files of their favourite newspapers. Amongst the most dramatic episodes narrated by him is the tale of the historic wireless operator of the *Anglo Californian* as told in the messages extracted from the records of the vessel on which he was working and that which was hurrying to her rescue. The *Anglo Californian*, homeward bound from Montreal with a cargo of horses, was chased and shelled by a submarine, and radiated wireless calls for assistance, which were answered by a man-of-war below the horizon. Just as the captain had determined, in view of the severe bombardment which he was enduring, to abandon his ship, a wireless message told him to hold on as long as possible, and he proceeded on his course. The hot shell-fire which followed killed the captain and eight hands, besides twenty horses, and readers will get some idea of heroic fortitude displayed by these British merchantmen when they remember that *they possessed no weapon wherewith to retaliate.* The wireless messages, reproduced textually by Mr. Noyes, describe how the *Anglo Californian's* course was altered in accordance with the directions transmitted from the warship. The latter was at length able to radiate the welcome news, "Can see your smoke. Hold "on. Funnel red and blue bands with yellow star." All the time the submarine was following hard astern, firing at the wireless aerials, the only means of defence the unfortunate vessel possessed. Every now and again the transport operator would send out a pathetic message like "For God's sake hurry up. Firing like "blazes." In one of his "calls" the telegraphist described to his brother operator on the warship how he was discharging his duty lying on the floor with broken glass all round him, "the place stinking with gunpowder." At last the British man-of-war came up, and the *Anglo Californian's* operator announced that "submarine has dived," and was asked to report her trail at intervals.

The name of the hero of this episode is Mr. J. F. Rea, who on the occasion above referred to carried out the "Marconi tradition" of fortitude in times of stress and danger which we are proud to think has now become universally recognised. The British Admiralty Board wrote to the owners of the *Anglo Californian*, paying a very high tribute to the officers and crew, and especially commending the behaviour of Mr. Rea, who was presented by them with a gold watch suitably inscribed, in recognition of his conduct. The drama so vividly described by Mr. Noyes lasted four hours.

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War Notes

In our January issue (pages 763 to 765) we published a description of a wireless man's adventures with the force of General Smuts, and we have since seen a further communication on the same subject from a teacher formerly attached to the Hales Owen College, Manchester, now serving with the wireless Signalling Section of the British Forces in German East Africa. He, like our earlier correspondent, speaks feelingly of the hard work involved in hewing a track through pathless scrub, and emphasises the delight of his companions and himself "to see a railway line again, after eight "months' wandering about uncivilised Africa." He also tells the story of a German corporal, *ex* the wrecked German cruiser *Königsberg*, who went into a native kraal to get milk, was made prisoner by the natives while drinking it, and handed over to the British.

More about our African Forces.

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On page 841 will be found a reference to the violation of the old-time "Codes of Honour" by our present enemies, and we have given an example of how this violation has been brought "right home" to a German submarine on the occasion when a Dutch vessel answered a bogus call of distress. A similar instance occurred when the Italian steamer *Duca Degli Abruzzi* arrived at Genoa without having met any German submarine on the voyage, and learned that other vessels had received S O S messages purporting to have been sent out by herself. The infamy of such action on our enemy's part is beyond comment.

Bogus Wireless.

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It has become a commonplace amongst naval experts that through the agency of radio-telegraphy the British Fleet is able to maintain its blockade against Germany without hanging round the exits to German ports after the old traditional fashion. Some of the recent critics, in their desire to tilt at everything and everybody, would appear to have forgotten this, and have been talking as though the British Fleet is failing to pursue its traditional policy. Of course, such criticism only displays the out-of-date nature of their authors' knowledge. Wireless telegraphy has rendered the old-fashioned short-range blockade as unnecessary to-day as it used to be laborious, dangerous and (frequently) ineffective in times gone by.

"Times change."

* * * * * *

There are great differences between the conditions of to-day and a hundred years ago. These lie in the greater speed of ships, in the longer range of guns, in the menace of the torpedo as fired from ships, destroyers and submarines, in the menace of mines, the use of aircraft as scouts, and of wireless telegraphy.

The gallant First Sea Lord worked out the above dictum in some detail, but what it comes to, as far as the blockade is concerned, is that the necessity under modern conditions of remaining at a greater distance from the enemy's blockaded coast than in olden days is more than counterbalanced by the rapidity with which news can be radiated, and the speed of modern vessels.

What Says Sir John Jellicoe?

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Wireless Signals in the Home

More Marconi Gramophone Records. Important New Arrangements

ELEVEN months have now elapsed since we first announced the publication of *Gramophone Records of Wireless Signals*, the success of which was immediate. No sooner had our descriptive article appeared than orders came in from all parts of the world. Young men studying to become wireless operators, boy scouts, signallers in the Army and Navy, wireless operators at sea, teachers in technical colleges—all hastened to obtain the new discs. It will not surprise our readers, therefore, to learn that the whole of the first large edition of these records is exhausted, and a second edition is now being prepared.

This month we have two important and interesting announcements to make. The first concerns a reduction in price, which has been made possible by the large sales, and the second is in reference to an entirely new series containing many novel features.

PRICE REDUCED.

From the 1st of February the Marconi Official Training Signals, issued as "His Master's Voice" gramophone records, will be obtainable from all accredited dealers in "His Master's Voice" discs at the price of 2s. 6d. per double-sided 10-inch record, or 15s. for the set of six. In countries other than the United Kingdom the price of records will be that charged for a standard 10-inch double-sided "His Master's Voice" record, and so long as our readers are within reach of an accredited dealer they will save the cost of postage—a large item in many cases. For the benefit of those readers in this country who have no agent in their town, the Wireless Press, Limited, will supply the discs at 2s. 6d. each, postage and packing 8d. extra. In the case of the whole series being ordered at once postage and packing will be free

SIX NEW RECORDS.

We are also pleased to announce that the arrangements for the issue of a new series of six double-sided records have now been completed, and the new records will shortly be obtainable at the same price and in the same manner as that detailed above for the first series.

SOUNDER SIGNALS.

In response to a considerable demand we have prepared a double-sided record of "Sounder" signals for the purpose of giving instruction in the reception of signals on this type of receiver. As the Sounder is largely used in wireless stations on circuits which connect the landline telegraph with the radio station, all operators who anticipate appointment to installations on shore should obtain these discs, so that they may not have to plead ignorance of this form of reception. On one side of the record we find the Morse Code sent slowly and exactly as printed in the Postmaster-General's Handbook, and on the other side a simple press message at 10 and 12 words a minute. To those of our readers who are not acquainted with the first series (described fully in the March, 1916, issue of this magazine), we would state

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that by altering the speed regulator of the gramophone the speed of the signals can be very materially changed. Thus on most machines a record which when run at normal speeds would give signals of 10 words a minute, run at the slowest would give 5 or 6, and at the fastest at least 14 or 15 words per minute respectively. The flexibility of this method of receiving is thus at one demonstrated.

FOREIGN LANGUAGES.

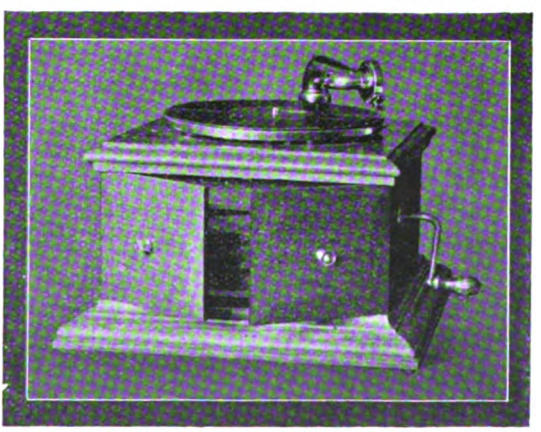
The second record contains on one side a press message in French at a good working speed and on the other a similar message in Italian. The third disc contains on one side Spanish and the other side Portuguese. The two records thus give instruction in the reception of signals in no less than four languages. The excellent practice afforded by the reception of the messages in foreign languages will be greatly appreciated by many of our readers who are anxious to avoid what may be termed "guesswork" reception—so easy when the messages are in plain English.

FIGURES AND FRACTIONS.

The fourth disc will be specially popular, containing on one side nothing but figures and fractions. At most wireless schools far too little practice is given in figure reception, and it is by no means unusual to find an applicant for employment in the Marconi Company able to receive excellently in plain language and code, but worse than indifferently in figures. Many experienced operators will welcome the opportunity of practising figure reception at a high speed, for, although the record run at its normal speed gives reception at 23 or 24 words per minute, it can be run at a speed of well over 30 words per minute.

A TEST FOR CONCENTRATION.

The other side of the fourth record will cause a great deal of amusement, and although we anticipate that it will be largely purchased by many people who have no desire to master the mysteries of the Morse Code, at the same time it will be extensively bought by wireless students of all stages of advancement. Briefly, it consists of a Poldhu Press Message with almost every conceivable interruption from extraneous noises. The record starts off with seven bells on the ship's bell, followed by the well-known preliminary V's of Poldhu, leading on to a typical bulletin of press from the famous "ZZ" station. Very few letters have been transmitted before the voices of men on deck are heard, and a raucous voice calls upon some person unknown to "bring the bosun here." The grating of boxes being dragged along the deck and the shrill note of a whistle then obtrude themselves



THE EXPERT TEACHER IN YOUR HOME.

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upon the ear, and this interruption has hardly ceased before an inquiry from a passenger who has intruded himself into the cabin creates further exasperation: "Operator, can you send this message?" "He doesn't take the slightest notice of me!" and other similar remarks follow rapidly one upon the other, and among the medley of voices, whistles and bells the piping note of Poldhu still goes on. The object of the record is to give practice in concentration, and although on first hearing the new student will be inclined to think that it is impossible to receive in such a general "mix-up," he will find later that practically all the message can be transcribed without error. Frankly this is a difficult record—it is intended to be—but it will afford splendid practice.

In case the would-be operator feels discouraged on hearing this record, we would explain that conditions are very rarely as bad as this, and in any case the headpiece pressed closely to the ears cuts off a great deal of the outside noises. Nevertheless, on some ships conditions approximate those of this disc, and a number of senior operators who have had an opportunity of hearing this record state that the interruptions are very natural.

A SHIP IN DISTRESS.

In the fifth disc we pass from the humorous to the dramatic. On starting the record we hear one ship telling another to "wait for a further message." Suddenly in the distance, on a high whistling note, the famous S O S call is heard, the cry of distress being immediately answered by two vessels. Of these the ship in peril selects one as being the nearer, and transmits to it the message giving its position. A suitable reply is sent, the different notes of the three ships working together and handling their traffic in a highly skilful and expeditious manner, giving a record which is unsurpassed for verisimilitude. On the second side of this record practice is given in the calling up of a coast station and the transmission of a "time rush." The coast station called promptly answers, and both ship and coast station send messages. The speed of transmission being comparatively high, this record is excellent for advanced practice.

MORE JAMMING.

The last disc of the second series contains on one side messages from ship to shore properly numbered and timed, and on the other from shore to ship similarly sent. Transmission is effected at 26 or 27 words per minute, and both sides are severely "jammed" by French press. This jamming record is much more difficult than that of the first series, and affords exercise in both English and French.

USEFUL HINTS.

We take this opportunity of reminding our readers that, whilst these records can be played on any disc gramophone using the needle method of reproduction, they cannot be played on gramophones using jewelled points or sapphires. Of these latter machines the Pathé is the best known. It is possible, however, to obtain from Messrs. Pathé Frères an adapter and needle sound box, enabling needle records to be played, and readers who have Pathé machines will have to obtain this before they can utilise the wireless records. As the cost of the change is only a few shillings, and as furthermore the two types of sound box are interchangeable, no possessor of a disc gramophone is now debarred from benefiting from this excellent means of instruction.

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Modifying the Sound.

Great modification of sound is possible by the use of various kinds of needles. "His Master's Voice" gramophone needles, which we strongly recommended as specially designed for giving the best results with "His Master's Voice" records, are obtainable in three grades, *i.e.*, "Pianissimo," "Piano," and "Forte," the first giving very soft reproduction, the second medium, and the third loud. It is just as well to obtain all three grades of needle, so that practising in reading weak signals can be obtained where necessary. The loud needles should only be used for class work, the medium needles being most suited to work in the average room. Although the horn type of machine gives the greater strength of sound, the hornless models are equally suitable for home study; and, indeed, with a soft needle, and by opening or shutting the modifying doors, the student can obtain all the practice he desires in the transcription of weak signals without moving his position in relation to the gramophone or altering the needle on the machine.

It should be unnecessary to remind users of gramophone needles that the point must be changed after every record. Not only does the reproduction suffer when a needle is used more than once, but the surface of the record is injured and its life considerably lessened. A velvet pad, such as is sold by hatters for polishing silk hats, will be found very useful for dusting the records before playing, and if dirt is removed in this way before each reproduction the very best results will be obtained.

The Use of Telephone Receivers.

In our November issue we printed a note regarding a new use for the Marconi records, in which we described the methods used by J. Mr. H. Morris for reproducing the wireless signals from the gramophone records into the standard telephone head-pieces. Those of our readers who wish to practise reception with the telephone receivers should refer back to this note, which gives all the necessary information.

It is anticipated that the new records will be on the market by March 1st.

King Constantine and Wireless

Newspaper readers have long been acquainted with the fact that the Central Powers have been cut off from the rest of the world, as far as cable communication is concerned, ever since the beginning of the war. It is in consequence of this cable isolation that we have become so familiar with the "German Wireless" items which figure prominently every day in our Press. Nevertheless, every now and again we are reminded by some picturesque incident of the disabilities suffered in consequence by our enemies. Only the other day, when King Constantine of Greece perpetrated his treacherous stroke against the Allies' landing party, was direct touch with Berlin regained by him through his retaking possession of the Greek wireless installations. He lost no time in utilising his opportunities, and the Greek man-of-war, the *Hydra* (now under the control of the Entente), speedily detected the fact that wireless messages were passing between Tino and the German authorities. In addition to wireless, other methods of interchanging messages have been employed. A German aeroplane has played the part of postman at Athens, whilst Zeppelins have been employed to drop mail bags at Larissa.

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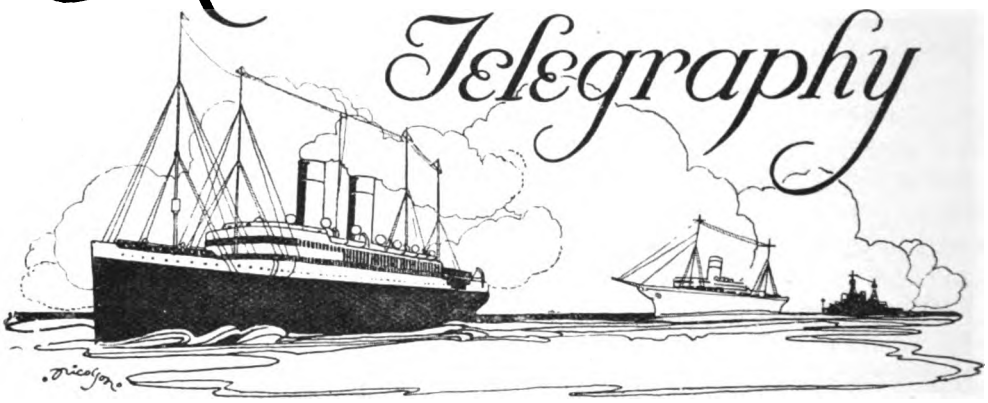
Maritime Wireless Telegraphy



Fishing for Men.

The radiation at sea of wireless messages has often been picturesquely spoken of as a " net " whose meshes are formed by the criss-crossing of the various streamers of ether waves. An apt illustration of what this metaphorical term is intended to convey was recently furnished on the occasion of the wreck of the Spanish steamer *Pio Nono*. This was a vessel of 6,500 tons register, *en route* from New Orleans to Barcelona. In the earlier part of December, 1916, she encountered a series of heavy storms, culminating in a hurricane with heavy cross-seas. After having been for some time subjected to this severe buffeting she became waterlogged, and it was thought best to abandon her. The crew and officers, numbering between 60 and 70, were divided between the four boats which were successfully launched, and although they did their best to keep in company, darkness and weather proved too much for them so that the little craft speedily drifted apart. We owe our knowledge of what next occurred to Dr. José de Belda, the ship's doctor, who with his ten companions were, fortunately for themselves, not many hours in their boat before a rescuer arrived. As it was, several of the men were found to be in a state of collapse when they were carried into safety on board their " Ark of Refuge." The rescuing vessel, as soon as the captain learned that there were three other boatloads in peril, set to work to search for them, but without success. They then started radiating wireless messages calling upon anyone who received them to aid in the search.

As the disaster occurred on one of the main routes of ocean travel, the *Pio Nono* having foundered about 300 miles south-east of Madeira, the tale was soon taken up first by one vessel and then by another, until the neighbouring ether was swept by a " wireless net " straining to rescue the unfortunate Spaniards from the perils of the deep. Eventually a radio message arrived from a ship bound for Las Palmas, announcing that she had succeeded in rescuing yet another boatload. Of the remaining two boats, however, no trace could be found, and all hope seems to have been abandoned. Thus only 22, or less than half the personnel, escaped.

The mental picture called up in such a sweeping of the sea by the " wireless net " constitutes a striking fulfilment (though in a slightly different sense) of the

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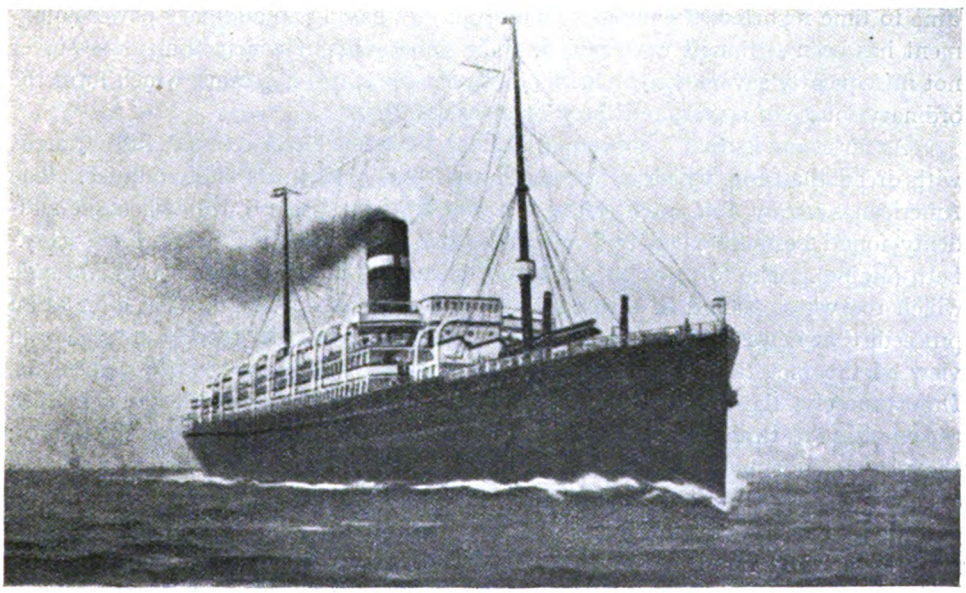
famous prophecy of the Divine Founder of Christianity, "Ye shall become fishers of men."

WIRELESS—WITH DISCRETION.

Cautionary wireless messages to and from ships on the High Seas have proved of the greatest utility all through the present war. So deep was the impression made upon the American mind of the piratical raid of the *U*53 in October, 1916, its depredations, and the large number of possible victims saved from its "frightfulness" by wireless warnings, that their magazines still occupy themselves with the subject, and the *Wireless Age* for December contains a dramatic personal narrative contributed by the wireless operator on board the s.s. *Stephano*, one of the earliest victims. Incidentally, our American contemporary characterises the journalistic side of the matter as a "wireless triumph," pointing out that—thanks to this means of communication—the American papers were able to print full details of the disasters in their late editions published on the same day.

Warnings against the commerce-raider, whose list of victims recently figured in the British daily Press, were issued in good time by the Naval Authorities, and doubtless these warnings have proved effective in many cases.

In a recent award for salvage, however, made in the Admiralty Court towards the latter part of January, we have an illustration of the "Other Side of the Shield." Wireless, like everything else, often requires to be used with discretion, or the messages which are intended to help may aid the enemy to destroy. A case in point was furnished in a recent award by Sir Samuel Evans of £8,500 salvage to the Norwegian tank steamer *Caloric* for services rendered to the Japanese liner *Tansan Maru* in the North Atlantic. The latter *en route* for England broke her propeller shaft, and—on meeting the *Caloric*, also bound for England—requested her to send



THE S.S. RIJNDAM, WHOSE "WIRELESS" ADVENTURES HAVE BEEN DESCRIBED IN OUR PAGES ON SEVERAL OCCASIONS.

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a wireless message giving the position of the *Tansan Maru*, and asking for tugs. The Norwegian master, however, judged it imprudent to send such a message lest it might attract the attention of enemy submarines, and towed the *Tansan Maru* all the way to Berehaven, a matter of 621 miles.

TWO DRAMATIC RESCUES FROM FIRE AND FOG.

Fire at sea, with the destructive element in possession of the upper hand! Can any situation be more awfully critical for unhappy voyagers? When the ss. *Congress*, one of the largest units of the Pacific Steamship Company's fleet, was found to be on fire in the neighbourhood of Coos Bay, Oregon, with the flames making rapid headway, and no ship in sight, the 233 passengers and 175 members of the crew who constituted her personnel found themselves in a predicament that might well have cowed the stoutest heart. Captain Cousins, who was in command, ordered the vessel to be headed for the nearest point on the coast, and instructed the wireless operator, Mr. R. H. Brower, to send out the SOS message. As soon as the telegraphist proceeded to the execution of his duty, however, tests showed that the fire had cut off the power of the main set, and the auxiliary equipment had to be used in order to flash the appeal. The Marconi station at Eureka was the first to answer, although the naval installation at Cape Blanco came in only five minutes later. Ten miles off Coos Bay Bar, when the decks of the *Congress* were scorching, those on board half-choked by smoke, and the vessel plainly in imminent danger of being completely enveloped in flames, everyone, passengers and crew alike, took to the boats. It was indeed fortunate that rescue craft were already on the scene; for, hardly had the personnel of the unhappy vessel left her, than she flared up like a torch, the flames spreading from stem to stern, as if to impress the occupants of the lifeboats with the awful fate from which they had so narrowly escaped. On this occasion, as on others which we have from time to time reported, the immense importance of having an auxiliary power equipment has been strikingly exemplified. The same accident which brings the danger not infrequently severs the connection between the ship's dynamos, which form the ordinary source of power, and the wireless apparatus.

As far as navigation is concerned, seamen have few bugbears more fully fraught with dread than fog, which stifles sound and sight alike in its chill embrace. The American s.s. *Bay State* was feeling her way through a dense mist when she suddenly found herself "piled up" on the ledges off McKenny's Point, Cape Elizabeth (Maine). The force of impact tore a great rent in the ship's bottom, through which the water poured in torrents into her hold. So rapidly did the inundation proceed, that it was of the utmost importance to summon aid quickly, especially in view of the fact that the unhappy vessel contained as many as 250 passengers. Unfortunately, the same shock that ripped her plates had inflicted damage upon the wireless set, throwing the top off the condenser case, besides breaking the tabs off the plates. Fortunately, Mr. A. R. Gardner, the Marconi operator, was able to effect repairs with but little delay, and despite all his disadvantages succeeded in getting into communication with the Cape Elizabeth radio station within three minutes of the accident. A revenue cutter and tugs were quickly on the scene, but their efforts to haul the *Bay State* off into deep water proved ineffectual, and the stranded vessel's inmates had to be transferred by rope ladders into small boats and thence to the rescue vessels.

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In Defence of Wireless Students.

We desire to express to our contemporaries in Aberdeen our appreciation of the recent opening of their columns to the defence of wireless students against a thoughtless charge of lack of patriotism levelled against the latter at a recent sitting of the Aberdeen City Tribunal. Mr. Kingsley Bell, writing from the Scottish Wireless College, points out that it would be as unfair to dub wireless students "unpatriotic" as it would be to apply the same epithet to the munition workers. The part played by wireless telegraphy in the present war has been all important, and has affected every department of military activities. Now wireless apparatus without operators would be as useless as big guns without artillerists. There appears to be, amongst a number of mistaken enthusiasts, an idea that only men who spend half their time wading in the mud of Flanders are acting patriotically towards the country so dear to us all.

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Cherchez la Femme.

Sailor-men, perhaps because they spend so large a part of their lives cut off from intercourse with the fairer sex, are characterised by more than their share of chivalry. *Cherchez la femme* is a proverb which has hitherto been meaningless at sea, as far, at all events, as British men-of-war are concerned; now we learn from our contemporary, the *Daily Sketch*, that this immunity is threatened! It appears that a lady recently applied for the position of wireless telegraphist on board a British Dreadnought, stating that she was attending a school, hoped soon to be proficient, and would be willing to undertake the duty without pay. The gallant officer, to whose lot it fell to answer the missive, wrote courteously, pointing out that under the imperfect conditions at present ruling, wireless operating on His Majesty's ships of war was carried out by men only; but he added that, in the future, such positions might *possibly* be thrown open to ladies. His fair correspondent thanked him, asking that in such an event he would not forget her, and added the characteristic reminder that she, at a recent ball, enjoyed the pleasure of twice "taking the floor" with him.

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Training in Radiotelegraphy.

Last month we referred to the projected establishment of a new wireless school at Rutherford College, Newcastle-on-Tyne, and the preliminary steps which had

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been taken in the matter. We are now able to report further progress. Councillor George Lunn (the Lord Mayor of Newcastle) at a recent meeting of the local education authorities, announced that the local shipowners had contributed £2,000 towards the installation and had thereby practically covered the cost.

This municipal action at Newcastle is typical of other activities in a similar direction which are going on at other great provincial centres. The Birmingham Education Committee, for instance, some time ago, at the request of the local representative of the Royal Naval Volunteer Reserve, arranged a course for recruits awaiting drafts for wireless duties. Classes started at the end of last June, being held on every week-night (Saturdays excepted) at a fee of 5s. per month.

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THE PLACE OF WIRELESS IN AN IMPERIAL SCHEME.

There have been recently printed, for the benefit of general readers, addresses delivered by various eminent public men at the series of Conferences arranged by the Empire Parliamentary Committee of the House of Commons, during last year's official visit to this country of Representatives of the various Dominion Parliaments. These addresses include contributions by Earl Grey, Viscount Milner, Lord Islington, Sir George Foster and Lord Sydenham.

Owing to Lord Milner's recent inclusion in the Inner Council of the nation, the paper contributed by him under the title of "The Constitutional Position" has attracted considerable and well-deserved attention from the general Press. His lordship therein outlines a scheme which several eminent publicists characterise as an excellent basis for discussion.

Readers of THE WIRELESS WORLD take a double interest in the forthcoming developments of the grand Imperialistic idea. Firstly because, as loyal Englishmen, we are all of us deeply concerned in the close-welding of the Empire which this war has done so much to hasten; and secondly, because we realise the importance of the part that wireless must inevitably play in the practical working out of any such project as that outlined by Lord Milner. Increase in cheap and speedy means of communication between the various parts of the Empire is an essential condition of progress towards the goal. The present is not a suitable time for dealing at any length with the Imperial wireless chain, at one time so fruitful a source of debate, but we *do* feel it not inopportune to remind our readers of the idea promulgated by the late Sir John Henniker Heaton, that telegrams ought to be interchangeable between all parts of the British Empire at the cost of 1d. per word, with a minimum of 1s. Such a reform would do more to bind the various units of the British Empire more closely together than any number of Conferences, and its consummation could only be brought within range of "Practical Politics" by wireless. His realisation of this fact was largely responsible for the great postal reformer's enthusiastic interest in the development of radiotelegraphy. The "Life of Sir John Henniker Heaton," which we reviewed at length in our issue of October last (pages 524 to 526), contains a number of future reforms projected by the distinguished subject of the biography, and possesses, on that account, a living interest quite apart from its fascinating account of a notable personality.

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The Wireless Man

EDITORIAL NOTE.—*The following graphic description of the life of a wireless operator at the Front will help to bring home to our readers the perils that are daily faced by the ever-increasing army of radiotelegraphists attached to the British Forces. It comes to us straight from the trenches, and is no "armchair" essay on imagined perils. The incidents so vividly described actually took place not very long ago.*

BATTALION headquarters are located in the cellars of a row of ruined blackened cottages just behind the supports. The ruins are gaunt, grim—hideous almost. To the casual observer they are merely a line of blasted dwellings left in the wake of a retreating and spiteful army—with not a living soul within miles. If we made a more minute inspection perhaps we would observe shaftways leading to the cellars, and we would also perceive that the said cellars were illuminated brilliantly, yet cunningly, by electrics. Here the brains of the battalion holding the few hundred odd yards of line out in front are located.

We pause before a thin wire which seems to rise out of the earth and disappear into the clouds. On making a further examination we trace a spidery system of wires, cleverly hung from the tottering gables and blasted trees. A few yards off you decide it would be invisible almost. You peer down the shaftway into the cellar of a one-time café, and are bewildered to see a figure in khaki, with headgear adjusted, and a vague glittering heap of apparatus before him, neatly arranged on an impromptu table consisting of two battered horse-hair chairs and a few planks. Another dim figure, with his gumboots protruding from the folds of an army blanket, is huddled up in the corner—asleep. Such is the battalion wireless station.

The operator seems to be listening intently. His swiftly-moving fingers make adjustments ceaselessly. His pad and pencil are occasionally used, then laid aside.

Outside the dusk is deepening and soon the first Very light soars up with a trail of sparks, flares up and hangs for a few seconds, dancing and shimmering and throwing the ruins and the drab landscape into ivory on ebony relief. It fades and falls gently into the wilderness of No Man's Land. A machine-gun coughs in an uncertain fashion for a second—then silence. There is a vague feeling of uneasiness in the air. The day has not been marked by any "strafing" of note, yet there's the feeling that precedes a typhoon in the air to-night. There's the usual low mumbling of artillery somewhere away to the south, but the guns immediately in our area are quiet.

Rats begin to rustle about—plump, easy-going beasts, which amble slowly off when disturbed.

The faint roll of wheeled transport can plainly be heard coming down wind from the German side, and you conjure up cameos of grey-clad drivers and hurrying teams straining to turn the cross-roads on which the English shrapnel may begin to burst any instant. There will be working parties too, and there's bound to be despatch riders and transports, all hurrying on their various errands.

Your browsings are suddenly interrupted by the sight of three coloured rockets which flash up suddenly out in front. Next second there is a soft roll as of a gong

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beaten swiftly and quietly. Next instant pandemonium. "Gas!" "gas!" the word flies from cellar to cellar, from mouth to mouth.

Our artillery crashes out in a tremendous roll, and the gaunt landscape shimmers under stabs of violet, crimson and emerald fire. Within fifteen seconds they've laid a mathematically correct barrage immediately behind the first straggling line of field-grays. Another curtain of white-hot metal descends on the German communication trenches, supports, and gun emplacements. The artillery are now registering hits on all these targets; they've been "saving up" for an occasion such as this.

However, the German artillery is active, too. Our front line and its surroundings are being ploughed by H.E. "stuff" of heavy calibre. Black sixty-pound "Woolly Bears" are bursting everywhere. Bursting over places, perhaps, you've never seen a shell burst on before. Sulphury, yellow shrapnel is exploding almost overhead. And everywhere the Krupp speciality—the 5.9 delayed action "krump"—is sending scorched earth, acrid fumes, and whining splinters aloft with its peculiar "end of the world" roar. The tinier and even more awful "whizz bang" is arriving in showers with its fast, almost musical whine.

Suddenly a khaki-clad figure, with a gas helmet drawn over its head, staggers up the shaftway from the cellar—the wireless man—his aerials have "gone west" under the awful bombardment. Under his arm he carries a coil of wire, and a rope halliard is wrapped around his waist. He hurries about in the inferno—a ghostly figure—and presently locates the break, swiftly fixes it, and hauls the repaired spider's web into position again. He turns and swarms along the ruined wall towards the shaftway. Suddenly there is a vivid flash, a violent concussion, and an ear-splitting detonation, and a whole piece of wall and a dark sack-like object ascend in slow curves and a second later thud to earth again. You don't see the wireless man—he's lying on the other side of the ruin—shapeless and blackened. The second figure, whom last you saw asleep, rushes out and again makes good the damaged aerial. He makes the cellar in safety and continues to deal with his traffic, which is heavy—most of the land lines having been smashed early in the attack.

Two hours later the ground ceases to rock and gradually things go back to normal. The attack has failed dismally and the Very lights show grey-clad figures sprawling in the rank grass in all varieties of grotesque attitudes—where our machine-guns and shrapnel "got them."

Next day your eye chances on the official summary, and you learn that the Germans, under cover of dusk, launched gas on a front of a thousand yards, but their attack broke down under our barrage and machine-gun fire. If the casualty list interests you, you might notice that Sapper So-and-So, of the R.E., had joined the great majority. And you'd never think these two everyday announcements would be connected with each other in any way, would you?

PERIKON.

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Wave-Lengths Calculations

By P. BAILLIE.

THE travelling of an electric disturbance along a metal wire, ruled by the well-known "telegraphists' equation," can be simply considered in a few particular cases.

Let us assume the resistance of the wire to be negligible compared with its distributed capacity C_1 and distributed inductance L_1 (per unit length).

Consider the case of an earthed single wire aerial, of length l, having a localised inductance (self-induction coil) L_B in series at the lower part (Fig. 1) and oscillating freely with its proper period T. The disturbances travel along the conductor with a speed v given by $v = \frac{1}{\sqrt{L_1 C_1}}$, and it is easily shown that

$$\frac{v\,T}{2\,\pi} \operatorname{cotg} \frac{2\,\pi\,l}{v\,T} = \frac{L_B}{L_1} \qquad (1)$$

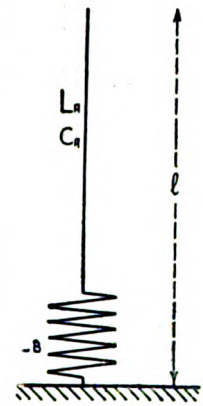

FIG. 1.

This antenna radiates Hertzian waves which travel through ether with a speed of 3×10^{10} centimetres per second. The wave-length λ of the radiated oscillations is then $\lambda = 3 \times 10^8 \times T$ metres.

Equation (1) can be written

$$\frac{1}{\theta} \operatorname{cotg} \theta = \frac{L_B}{l\,L_1} \qquad (2)$$

where $\theta = \frac{2\,\pi\,l}{v\,T}$. Then $\lambda = \frac{6\,\pi\,10^8\,l\sqrt{L_1 C_1}}{\theta}$

or $\lambda = \frac{6\,\pi\,10^8\sqrt{l\,L_1 \times l\,C_1}}{\theta}$ metres.

Now $l\,L_1$ and $l\,C_1$ are respectively the total inductance L_A and capacity C_A of the antenna (not including self-induction coil). Hence

$$\lambda = \frac{6\,\pi\,10^8\sqrt{L_A C_A}}{\theta} \text{ metres; } \theta \text{ being given by } \frac{1}{\theta} \operatorname{cotg} \theta = \frac{L_B}{L_A} \qquad (3)$$

This last transcendental equation possesses an infinite number of solutions. For instance, when $\frac{L_B}{L_A} = 1$, solutions of equation (4) are $\theta_1 = 0{\cdot}8596$ radian; $\theta_2 = 3{\cdot}42$ rad.; $\theta_3 = 6{\cdot}437$ rad., the corresponding wave-lengths being $\lambda_1 = 1{,}000$ metres; $\lambda_2 = 251$ m.; $\lambda_3 = 134$ m., etc.

The first solution corresponds to the "fundamental oscillation." It is that one we are concerned with, the others not being of any practical interest.

The following table gives fundamental solutions of equation (4) for different values of $\frac{L_B}{L_A}$ and λ can be calculated from above formula.

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Solutions of $cotg = \frac{L_B}{L_A} \cdot \theta$

$\frac{L_B}{L_A}$	θ rad.	$\frac{L_B}{L_A}$	θ rad.	$\frac{L_B}{L_A}$	θ rad.	$\frac{L_B}{L_A}$	θ rad.
0	$\frac{\pi}{2} = 1{\cdot}57$			27	0·1912	48	0·1437
0·05	1·498	7	0·3709	28	0·1877	49	0·1420
0·1	1·431	8	0·3491	29	0·1844	50	0·1407
0·2	1·314	9	0·3294	30	0·1814	52	0·1381
0·3	1·223	10	0·3133	31	0·1784	54	0·1356
0·4	1·145	11	0·2968	32	0·1755	55	0·1344
0·5	1·076	12	0·2843	33	0·1729	56	0·1331
0·6	1·021	13	0·2738	34	0·1703	58	0·1309
0·7	0·9730	14	0·2643	35	0·1680	60	0·1288
0·8	0·9303	15	0·2552	36	0·1658	62	0·1268
0·9	0·8932	16	0·2471	37	0·1633	64	0·1248
0	0·8596	17	0·2398	38	0·1612	65	0·1237
1·5	0·7374	18	0·2332	39	0·1592	66	0·1228
2	0·6532	19	0·2273	40	0·1574	68	0·1209
2·5	0·5948	20	0·2216	41	0·1555	70	0·1191
3	0·5467	21	0·2163	42	0·1536	75	0·1151
3·5	0·5101	22	0·2114	43	0·1518	80	0·1117
4	0·4774	23	0·2069	44	0·1500	85	0·1082
4·5	0·4547	24	0·2027	45	0·1482	90	0·1051
5	0·4329	25	0·1984	46	0·1468	95	0·1024
6	0·3980	26	0·1948	47	0·1451	100	0·0998

Consider now the same aerial but having a localised capacity (condenser) C instead of coil L_B (Fig. 2). The period T of the natural oscillations is then given by

$$1 + \frac{C_1}{C} \cdot \frac{v\,T}{2\pi} tg \frac{2\pi l}{v\,T} = 0$$

or

$$1 + \frac{l\,C_1}{C} \cdot \frac{v\,T}{2\pi l} tg \frac{2\pi l}{v\,T} = 0$$

the wave velocity along the conductor being $v = \frac{1}{\sqrt{L_1 C_1}}$.

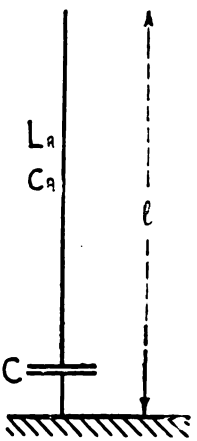

FIG. 2.

The wave-length of radiated oscillations is still given by

$$\lambda = \frac{6\pi\,10^8 \sqrt{L_A C_A}}{\theta},$$

but θ is a solution of

$$1 + \frac{C_A}{C} \cdot \frac{tg\,\theta}{\theta} = 0. \qquad (5)$$

We still have an infinite number of solutions for any given value of $\frac{C_A}{C}$; the fundamental are given below:—

$\frac{C}{C_A}$	θ rad.	$\frac{C}{C_A}$	θ rad.	$\frac{C}{C_A}$	θ rad.	$\frac{C}{C_A}$	θ rad.
0	$\pi = 3{\cdot}141592$	0·3	2·4958	1	2·0282	10	1·6321
0·05	3·0020	0·4	2·3801	1·5	1·9070	20	1·6020
0·1	2·8701	0·5	2·2903	2	1·8365	50	1·5833
0·2	2·6562	0·75	2·1300	5	1·6886	100	1·5772

Solutions of $\frac{tg\,\theta}{\theta} = -\left(\frac{C}{C_A}\right)$

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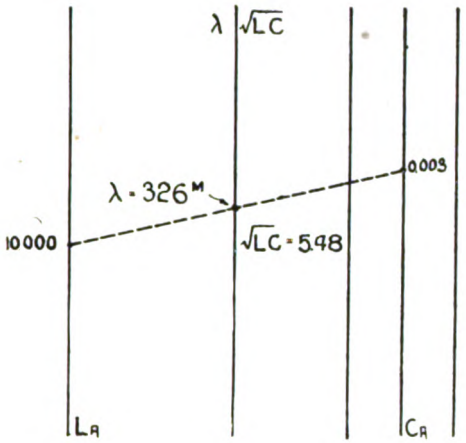

FIG. 3.

circuit, the condenser having a capacity of 0·003 mfd. and the self-induction being 10000 cm. (10 mhys.).

Draw a straight line (Fig. 3) from point 10,000 of scale L_A to point 0·003 of scale C_A. At the meeting of this line with middle scale you read the wave-length $\lambda = 326$ m., or the oscillation constant $\sqrt{L_A C_A} = 5{\cdot}48$.

Antennæ.—Suppose the wave-length is needed of an antenna having a proper capacity $C_A = 0{\cdot}0008$ mfd., and a proper self-inductance $L_A = 48000$ cm.

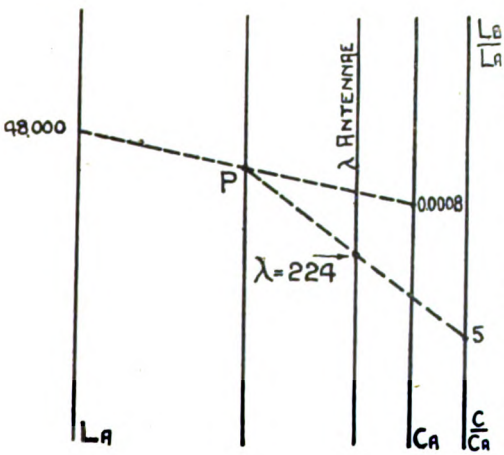

FIG. 4.

In formula (3) θ must be expressed in radians and L_A and C_A in homogeneous units. If L_A is expressed in centimetres and C_A in microfarads the formula is

$$\lambda = \frac{6\pi\sqrt{10}\sqrt{L_A C_A}}{\theta} \text{ metres.}$$

Results of Tables I. and II. have been combined with formula (3) in the accompanying abac. It gives, too, the wave-length of oscillating circuits according to Thomson formula. The use is as follows :—

Closed oscillatory circuits. Suppose one wants the wave-length of a closed

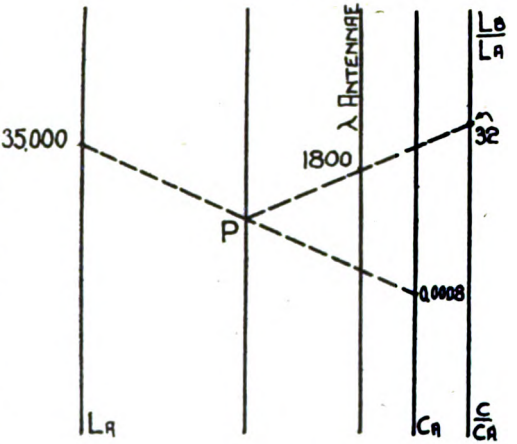

FIG. 5.

Suppose there is put in series with this antenna a condenser C having a capacity $C = 0{\cdot}004$ mfd.

Then $\frac{C}{C_A} = \frac{0{\cdot}004}{0{\cdot}0008} = 5.$

Draw a straight line (Fig. 4) from point 48000 of scale L_A to point 0·0008 of scale C_A. It meets the middle scale at P. Now draw a straight line from P to point $\frac{C}{C_A} = 5$ of right hand scale. The required wave-length is read at the meeting with scale "λ antennæ." Here $\lambda = 224$.

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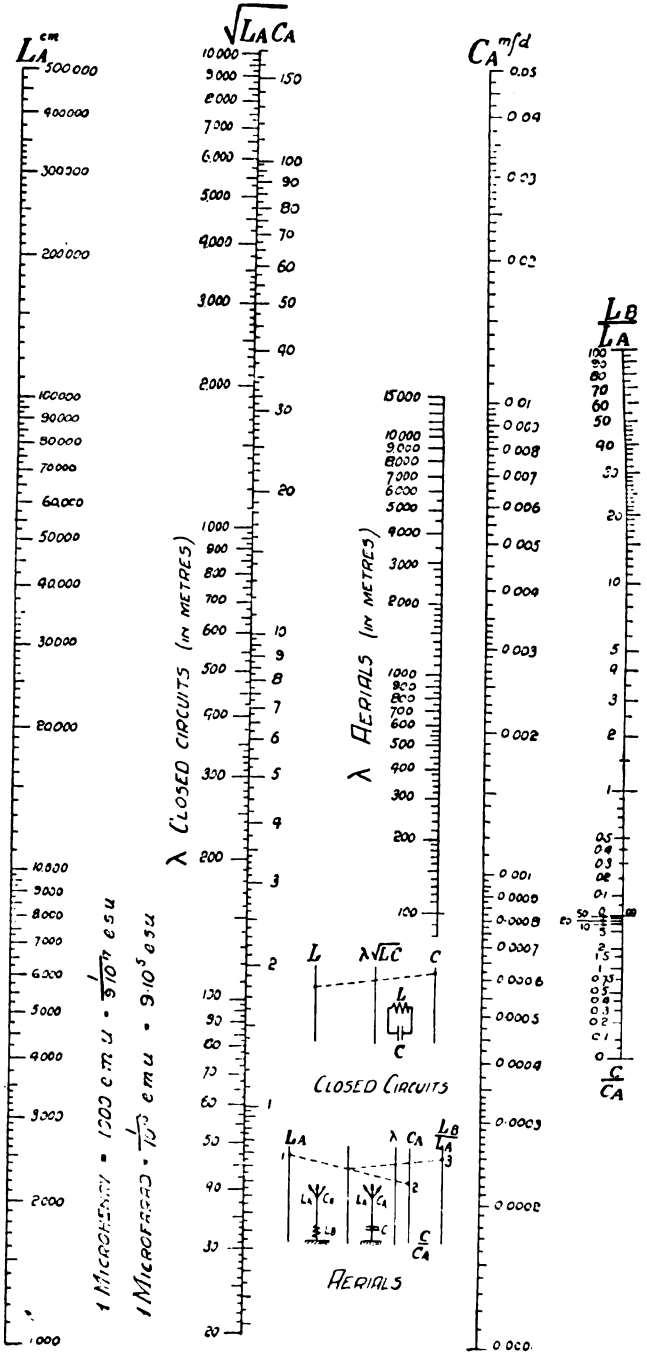

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The use is the same when instead of a condenser there is a self-induction coil L_B, but $\frac{C}{C_A}$ must be changed into $\frac{L_B}{L_A}$.

If an antenna has only distributed self-inductance and capacity take $\frac{L_B}{L_A}=0$, since $L_B=0$.

Reciprocal problems can be solved in the same way. Suppose it is required to find the self-induction L_B to be added in series with an antenna of $C_A=0{\cdot}0008$ mfds. and $L_A=35000$ cm. to give it a natural wave-length of 1800 metres.

Find as above the oscillation constant $\sqrt{L_AC_A}$ (point P, Fig. 5). Draw a straight line from P to point 1800 of "λ antennæ" scale. It meets scale $\frac{L_B}{L_A}$ at point 32. Then $L_B=32\times L_A=1120$ microhenrys.

It must be noticed that numbers of scale L_A or of scale C_A may be multiplied or divided by 100, 10000, etc..... ; numbers of λ scales are then to be multiplied or divided by 10, 100, etc..... Numbers of scales L_A and C_A may *simultaneously* be multiplied or divided by 10, 100, etc..... ; numbers of λ scales are then to be multiplied or divided by 10, 100, etc.....

A Novel American Receiving Device

OUR photograph shows an ingenious instrument recently produced in America and called the "Detectometer." It consists of a crystal detector and stand with an indicator at the back. The crystal is held in a small cup and an adjustable point in a spring holder presses on it from above. The two terminals for connection with the receiving tuner are seen on the front.

From the brief descriptions of this instrument which have so far been published, it would appear that the indicator at the back is a very sensitive form of milliampere-meter which gives a reading when signals are being received. Such an instrument might be made to act as a calling device by a slight modification.

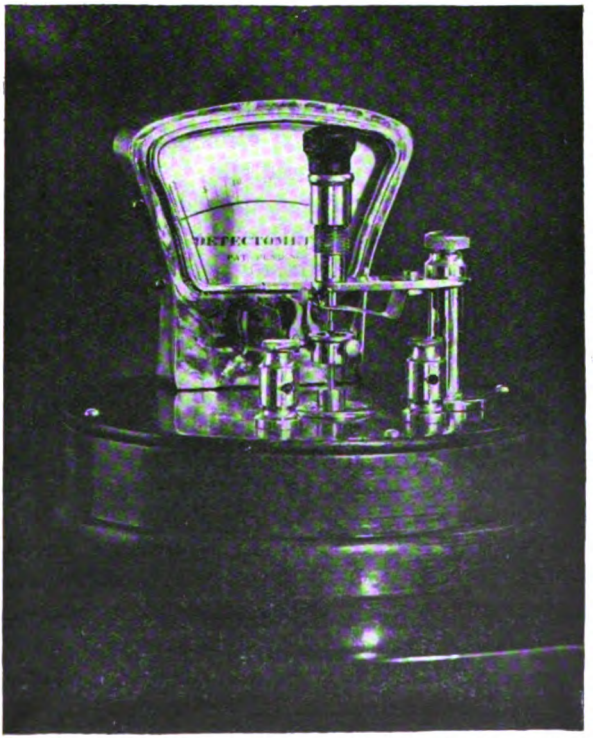

Photo: Frank C. Perkins.

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I HAVE previously referred to the Radio Legislation which is proposed by United States Government Officials, but we had no definite information on this subject until about the middle of November, when a draft of a bill entitled "An Act to Regulate Radio Communication" was placed in the hands of interested parties by Manager Todd, Chairman of the Inter-Departmental Committee on Radio Legislation. Representatives of commercial companies and others were invited to be present in Washington on November 22nd, 1916, where the Government Committee met those who came and discussed informally the provisions of the proposed bill and its effects. Commercial interests were represented by their executive heads and, as Secretary, I represented the Institute of Radio Engineers.

Professor Kennelly, President of the Institute, and Professor Goldsmith, Editor of *Publications*, addressed communications to the Government Committee protesting against the proposed bill.

Commander Todd summarised the bill interpreting the salient features of the proposed bill. Among other things, Commander Todd said that while this bill does not provide for the taking over by the Government of commercial radio stations at present, nevertheless "it sounds the note of Government ownership." The Marconi Company filed a written protest against the bill. Other commercial representatives asked questions without definitely committing themselves. Dr. Rose discussed the bill and strongly supported it, adding that, in his opinion, none of the provisions of the proposed bill would in any way stifle the development of the radio art. Commander Todd stated that the bill is the result of the Inter-Departmental Committee's efforts, ranging over a period of one year. He stated also that in view of the protests made, by certain interests, the Committee would again consider the bill and that certain changes might be made which would strengthen it. He advised that when the modifications are made, the bill will be forwarded for approval by each Department concerned, and thereafter it is expected that the bill in its final form will be presented at the next session of Congress, and the Commander added that the bill would go to Congress with the support of the administration.

An interesting paper on "The Classification and Elimination of Strays" was presented at the last meeting of the Institute of Radio Engineers held on December

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6th, 1916. The paper was written by Dr. C. J. de Groot, head of the Radio Service in Holland, Dutch East Indies. The paper was read by Professor Goldsmith and discussed by Messrs. Weagant, Armstrong and Alexanderson. A summary of the paper is given below:

Following a general discussion of radio *v.* submarine cable telegraphy, the work of the Radio Division of the Dutch East Indian Service is described.

A chain of stations installed for this Service are considered; their location, equipment and operation being described in considerable detail. The failure of the original contractor to furnish stations covering the requisite distances (which would have required six to eight times the actual available power) is critically considered.

The choice of station location and certain details; *e.g.*, precautions against earthquakes, are then treated.

A description of the origin and nature of strays and their classification is given; together with a number of methods for their elimination. In this connection, the Eccles theory of a tropical thunder-storm origin of all strays is disproven.

Strays fall into three classes, the origin, character, and mode of elimination of which are as follows:—

Type 1.—Strays originating in near-by thunder-storms of short range, of periodic electrical character, audible as sudden and loud widely separated clicks, and eliminated by radio or audio frequency compensation circuits.

Type 2.—Strays associated with low-lying rain clouds of very short range, of intermittent unidirectional electric character, audible as a constant hissing sound, and eliminated by the Dieckmann electrostatic shielding cage.

Type 3.—The most common or night strays, originating in cosmic bombardment of the Heaviside layer of audible range of several hundred miles (with the receivers used), audible as a continuous rattling noise, and eliminated by the Dieckmann cage.

The daily and seasonal variation of strays is considered in great detail, and a number of interesting conclusions are drawn.

DAVID SARNOFF.

Editorial Note: Professor Kennelly's letter to which Mr. Sarnoff refers reads as follows:—

DEPARTMENTAL COMMITTEE ON RADIO LEGISLATION, WASHINGTON, D.C.

CAMBRIDGE, November 17, 1916.

GENTLEMEN,—I am informed that new legislation is proposed, looking towards the invasion of the existing commercial field of radio communication in the United States by a certain department or departments of the Government, and that a hearing is proposed in the near future, at very short notice after the preparation and promulgation of the said proposed legislation.

The views of the Board of Directors of the Institute of Radio Engineers have recently been expressed officially upon this question, and I beg to state my endorsement of those views, which will doubtless be presented to your notice.

I am not commercially interested, either directly or indirectly, in any radio

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communication system, plant, company or organisation, so that I am not actuated by any financial considerations in urging my point of view before your committee. I am deeply interested, however, in the active development of the science and art of radio communication in America as a scientist, a teacher, an operator, a telegraphist and a U.S. citizen.

Although in the past the commercial field of radio communication has unfortunately been exploited by certain unscrupulous promoters, to the detriment of all interests involved, nevertheless, a large aggregate amount of capital, and the savings of U.S. citizens, has been honestly invested in it. I submit that it is the duty and interest of the Government to protect that investment and the American enterprise that goes with it.

If the Navy Department, or any other department of the Government, is allowed to compete in times of peace with existing industrial shore stations in the hands of American citizens, such competition is likely to degenerate into the confiscation of private property, because the Government now claims the right to regulate radio communication, under the terms of the London Convention, and it needs no argument to show that, with the Government in competition and at the same time construing the terms of regulation of their competitors, the competitors might quite easily, and very probably would, be regulated out of existence, and their properties confiscated at scrap valuation prices by the Government. I do not, of course, say that such injustice is the intention of any department of the Government, but I do say that any legislation which permits any branch of the Government to compete commercially with existing stations for messages in times of peace is likely to lead to the injustice above mentioned.

In times of war or national peril it is of course the duty of every citizen to sustain and co-operate with the Government in the general commandeering of all electric communication, radio or otherwise; but in times of peace such commandeering of private enterprises by the Government is not only fatal to the private interests, but also fatal to the Government interests. This is shown by the fact that in those countries of Europe where the telephone system is owned and operated entirely by the Government, the telephone communication of the country is in a relatively backward state by comparison either with the United States or with countries in which the telephone is not owned and operated by the Government. Statistics on this point are so ample and accessible that I need not refer to them here. In order, therefore, that the highest development of radio communication shall constantly be obtainable for the support of the Government in time of need, it is very desirable that inventions and improvements should be open to the public and to public competition. If the radio system is a Government institution, nearly all incentive for improvement and most of the inventive and scientific effort for development will cease. There will be no market for private enterprise. I therefore urgently contend that, for the present, there should be no legislation increasing the already great powers of the Government in the radio-communication field.

Yours respectfully,

(Signed) A. E. KENNELLY,

Professor of Electrical Engineering at Harvard University and Massachusetts Institute of Technology.

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Among the Operators

S.S. "CONCH."

IT is our sad duty to record this month the death of two members of the Marconi Company's operating staff, Messrs. D. Brewster and H. E. Holmes, both of the s.s. *Conch*, which was sunk by the enemy in December.

OPERATOR D. BREWSTER.

Mr. Douglas Brewster, the operator in charge, was 26 years of age in July last. Prior to taking up the profession of wireless telegraphy he was employed in an architect's office in his native town of Nottingham, and left that firm to study wireless at the East London Wireless Telegraph College. Obtaining his first-class certificate at this place, he entered the Marconi Company's London School in September, 1914, and shortly afterwards was appointed to the s.s. *Ascania*, from which he transferred to the *Conch* in April, 1915. He remained on board the *Conch* from that time until the ill-fated vessel was torpedoed. Deep sympathy is felt for the late Mr. Brewster's relatives in their sad bereavement.

Mr. Harry Ernest Holmes, junior operator, hailed from Dulwich, and was 18 years of age. After receiving his education in that town he obtained employment on the Marconi Company's clerical staff, and attended evening classes at the Marconi House School. Receiving his appointment to the operating staff in October, 1915, he made his first trip on a Russian vessel, the wireless installation of which was controlled by the Société Anonyme International Télégraphie Sans Fil. Later he returned to the English company, and was appointed to the *Conch* in March, 1916. The late Mr. Holmes's friends and fellow-workers at Marconi House will join with us in offering our sincerest sympathy to Mr. Holmes's relatives in their great loss.

OPERATOR H. E. HOLMES.

* * * * *

S.S. "IVERNIA."

The torpedoing of H.M. Transport *Ivernia* will be fresh in the memory of all our readers. The two operators on this ship

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OPERATOR R. H. NASH.

were Messrs. R. H. Nash and N. W. Campbell. Fortunately both of these gentlemen were among the rescued. Mr. Robert Hawker Nash, senior operator, who is 23 years of age, was born at Barton, in Lancashire. On completing his education in Manchester he entered the Liverpool Wireless Training College, where he obtained his Postmaster-General's certificate, and in January, 1913, entered the Marconi House School. Shortly afterwards he was appointed to the staff and proceeded to sea on the s.s. *Cornishman*, from which ship he transferred in the following year to the *Herefordshire*. Later he served on the s.s. *Canning* and *Persic*, and was appointed to the s.s. *Ivernia* in August, 1915. He remained on this vessel until she was sunk.

The junior operator, Mr. Norman William Campbell, was born in Cardiff in 1894. He was educated at Monmouth, and on leaving school took up a commercial appointment, in which he served three years. He received his preliminary wireless training at the South Wales Wireless College, and entered the Marconi House School in May, 1915. At the end of the following month he was appointed to the staff, and took duty on the s.s. *Sagamore*. Mr. Campbell transferred to the *Ivernia* in August, 1915, and remained on her until she was sunk.

We are pleased to say that both men were safely rescued, and so far as we know at present are none the worse for their experience.

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S.S. "CALEDONIA."

The loss of the liner *Caledonia* in December last was fully reported in the Press at the time. Two operators were carried, Messrs. J. A. Kelly and D. D. Cochrane. Mr. Kelly, the senior, was born in County Limerick in 1894, and on completing his general education took a course in wireless at the Northern Wireless School, Dublin. In September, 1913, he entered the Marconi House School, and in May of the following year was appointed to the staff. His first trip was on the s.s. *Cartagena*, and afterwards he served on a number of vessels, receiving his appointment to the *Caledonia* in March of last year. Mr. David Duncan Cochrane, the junior operator, is 20 years of age, and was born in Glasgow. After completing his education in that city he served for a few years in

OPERATOR N. W. CAMPBELL.

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various business appointments, later leaving this work to study wireless at the North British Wireless Schools in Glasgow. In May, 1916, he entered the Marconi House School, and three months later was appointed to the staff, the s.s. *Caledonia* being his first ship. We are very glad to say that both men were safely rescued.

OPERATOR J. KELLY.

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S.S "RUSSIAN."

The s.s. *Russian* carried two men, Messrs. C. C. Faraker and H. Jones. Mr. Cyril C. Faraker is 22 years of age, and lives at Brockley when at home. He received his education at Lowestoft and the Regent Street Polytechnic, and after leaving the latter institution studied to become a wireless operator. He received his Postmaster-General's first-class certificate at the British School of Telegraphy, and entered the Marconi House School in May, 1915. He was appointed to the staff almost immediately, and first went to sea on the s.s. *Saxon*, later transferring to the s.s. *Bornu*. He then served on several other ships, and was appointed to the *Russian* a year ago.

The second operator, Mr. Harry Jones, of Cardiff, will be twenty-one this month. After leaving school he entered his father's business, but left to study wireless at the South Wales Wireless School in Cardiff. In January of last year he entered the Marconi House School, and after a short stay was appointed to the staff, his first ship being the s.s. *El Cordobes*. From this vessel he was transferred to the *Russian* shortly afterwards, and remained on board until she was sunk.

OPERATOR D. COCHRANE.

We are pleased to announce that both operators were saved, although Mr. Jones suffered considerably from exposure. He had to cling on to a lifeboat for no less than six hours, and of 39 men he was one of 10 surviving. We trust he will make a speedy recovery.

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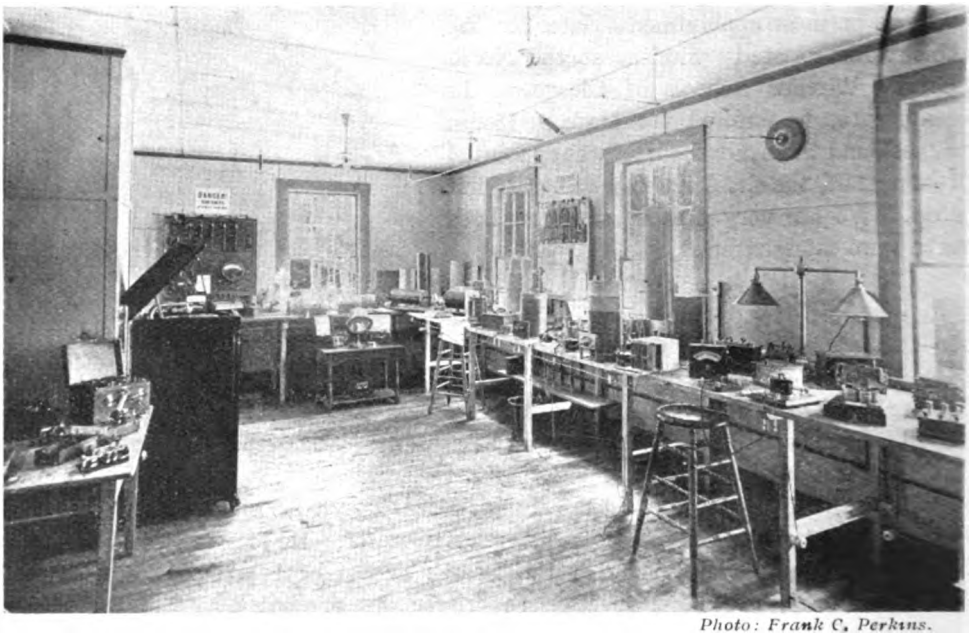

Photo: Frank C. Perkins.

INTERIOR OF THE RADIO RESEARCH LABORATORY AT TUFT'S COLLEGE, MASS.

An American Wireless Laboratory

Radio Research in Massachusetts

By FRANK C. PERKINS.

THE accompanying illustrations show the wireless equipment of the American Radio Research Laboratory at Tuft's College, Mass. In these photographs may be seen the electrical instruments in the wireless laboratory as well as the antenna machine-shop and one of the experimental rooms.

It is of interest to note that the American Radio and Research Laboratory had its beginning in the Tuft's Wireless Society founded at Tuft's College, 1910, and under the guidance of its president, Mr. H. J. Power, and its secretary, Mr. J. A. Prentiss, the society made rapid progress in the field of space telegraphy.

It was while associated with the wireless society that the promoters first realised the need of systematic research work in the development of radio-telegraphy and telephony. In order to undertake the solution of the existent problems of the science a new plant has been erected consisting of a 304-foot steel tower and a cement laboratory building. The tower supports an aerial of the umbrella type made up of 6,500 feet of phosphor-bronze wire, the whole being insulated to stand a working strain of 20,000 volts. An extremely good ground connection is obtained from 12,000 feet of copper wire buried in radial trenches over the entire tract of land.

It will be seen that facilities are thus provided for practical experimenting and

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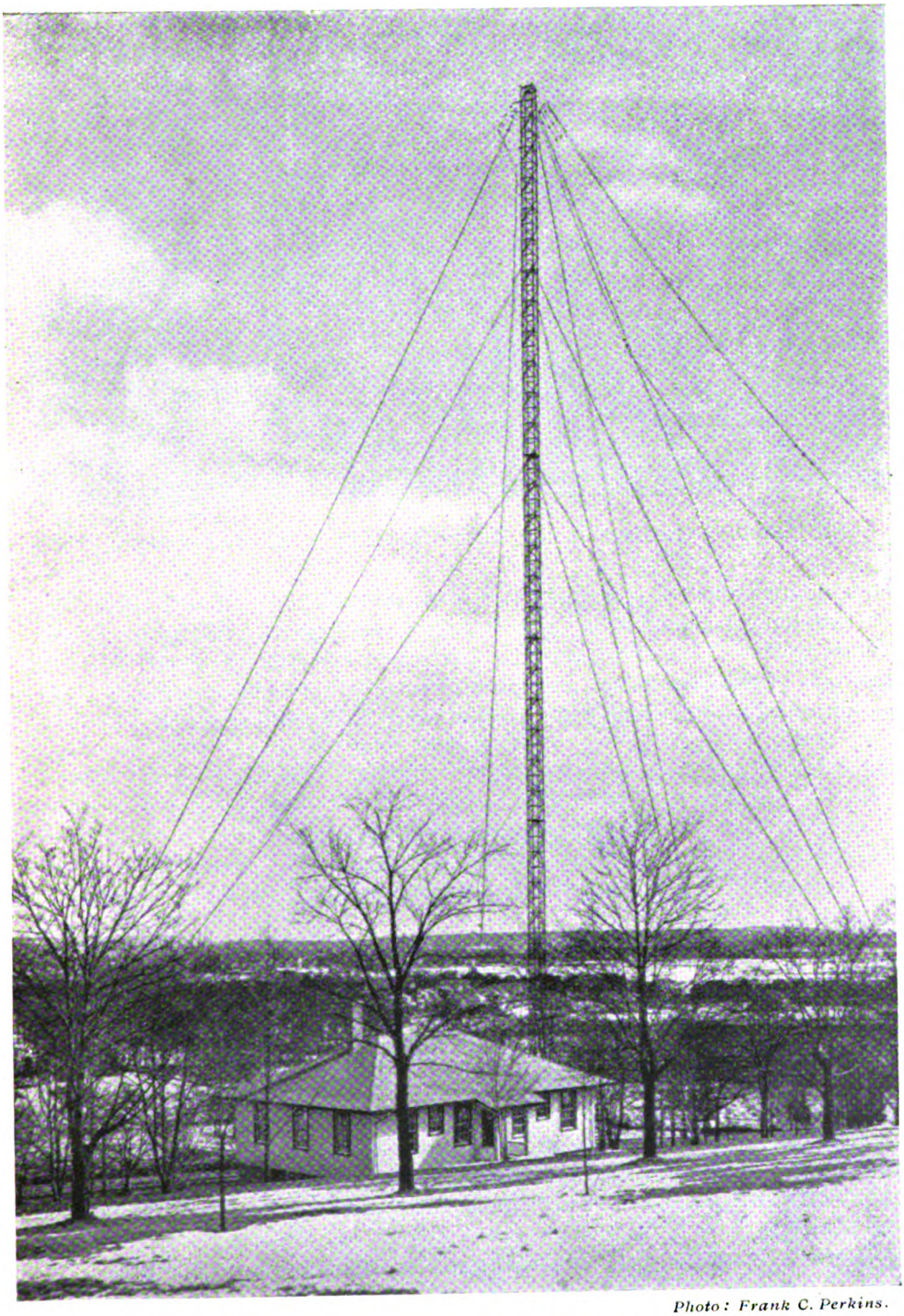

Photo: Frank C. Perkins.

THE AMERICAN RADIO RESEARCH LABORATORY AT TUFT'S COLLEGE, MASS.

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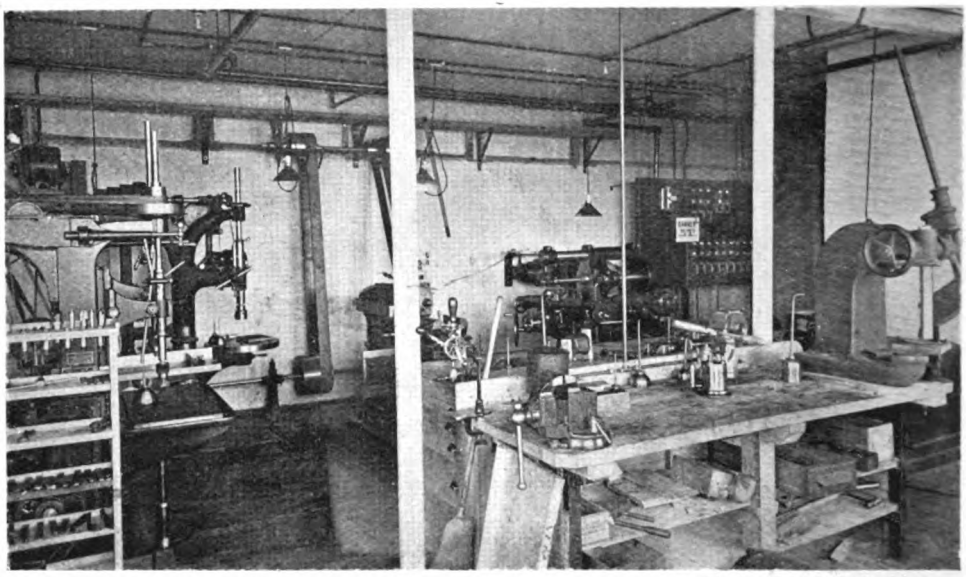

Photo: Frank C. Perkins.

INTERIOR OF THE WORKSHOP, TUFT'S COLLEGE RADIO LABORATORY.

testing of apparatus. The building is supported on a foundation as heavy as that of a five-storey building, giving great rigidity, enabling the performance of very accurate work. The building combines a research laboratory equipped with the latest type of precision meters and galvanometers with a finely-appointed machine shop furnished with machinery and tools of every kind and description.

Instructional Articles

Important Announcement.

WITH the present issue the series of Instructional Articles on Mathematics comes to a close after running through eighteen numbers of our magazine. These articles have proved exceedingly popular, and a large number of appreciative letters have been received from readers, who found in the lessons a clear explanation of many of the points of difficulty which had arisen in their wireless studies. We are now pleased to be able to announce that in due course these articles will be reprinted in amplified form as one of the standard text-books in the excellent student series of which *The Elementary Principles of Wireless Telegraphy*, *Handbook of Technical Instruction for Wireless Telegraphists*, and *The Wireless Transmission of Photographs* have already been published. Further announcements on this subject will be made at a later date.

A new series of Instructional Articles will be announced next month.

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Foreign and Colonial Notes

Columbia.

It is reported that the two Marconi outfits purchased by the Columbian Government some time ago will be delivered soon. It is intended to establish these two stations at Arauca and Orocue. The former is situated on the Arauca River, where it forms the boundary between Columbia and Venezuela, and the latter is on the Meta River, some 200 miles east of Bogota.

* * * * * *

New Zealand.

Wireless weather forecasts, which were discontinued at the commencement of the war, says the Secretary of the Marine Department, have been resumed during the year, and are sent out through the radio stations at Awanui, Wellington, and Awarua on the usual reporting nights, and at other times when deemed necessary. A daily wireless weather report was authorised from the Chatham Islands wireless station and commenced on April 8th, 1915; it has been maintained without a single break. Part of this message is also transmitted by cable to the Commonwealth Weather Bureau for research purposes. Forecasts are also occasionally transmitted to the Chatham Islands, for which a small charge is made by the Post Office, but usually the Wellington forecast suffices. Macquarie Island radio station was closed on October 14th, 1915. Since it was opened by Sir Douglas Mawson it has done very good work indeed and is one of the most notable researches in meteorology of the day. Since Sir Douglas Mawson sold the establishment to the Australian Government the New Zealand Government has contributed £500 per annum towards its upkeep, mainly the research into Antarctic conditions, and to link up with the Imperial Antarctic Expedition still in the South. It has also proved a valuable aid in forecasting in dealing with westerly storm areas. Some valuable records from the island were lost in the s.s. *Endeavour*, but there is much scope for research work upon the records which remain. The records were not entirely lost, for they had been partly transmitted by wireless before the originals were removed.—*Evening Post, Wellington.*

* * * * * *

Norway.

It is stated that a harbour is being constructed and a wireless telegraph station is being built in connection with the State coal mining operations which have been commenced in the newly discovered mines on Bjeerneoen (Bear Island), between Spitsbergen and the northern point of Norway.

* * * * * *

Porto Rico.

The wireless station at Ensenada, Porto Rico, gives notice that it will not accept messages which refer in any manner whatever to movements of any class of merchant ships belonging to belligerent countries, or sailing under belligerent flags, and that messages referring to merchant ships of other than belligerent countries will not be accepted unless the nationality is stated.—*Telegraph and Telephone Age.*

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SOLOMON ISLANDS.

Wireless communication from Australia has been opened with Tulagi (inland near the coast of the Island Florida in the Solomon Group) and with Ocean Island (Gilbert Islands). This is another step forward in linking up all the islands in the Pacific with the mainland and soon the romantic isolation of this part of the world will be completely swept away.

* * * * * *

UNITED STATES.

The Government has put a Navy officer on duty in the wireless station of the *New York Herald* at the Battery in New York City, with instructions to prevent the use of that station for sending unneutral messages to vessels at sea. This action resulted from the interception by the Brooklyn Navy Yard of a message sent out by the *Herald* wireless station to ships at sea reporting that the German submarine *U* 53 was operating off the Nantucket Lightship.—*Telegraph and Telephone Age.*

* * * * * *

The Drainage Board, Sanitary District of Chicago, has authorised an expenditure not to exceed $4,000 for the installation of wireless telephones at the generating station at Lockport and the receiving station in Chicago. The energy from Lockport is transmitted to Chicago, 32 miles distant, over a twin-circuit transmission line of steel towers at 44,000 volts. At certain seasons of the year lightning is extremely severe, putting the telephone system out of commission. It is to overcome this difficulty—namely, to permit communication between the two stations when most needed—that wireless telephones are to be installed.—*Electrical World.*

* * * * * * *

According to the *Electrical Experimenter*, in order to facilitate the technical work of determining the exact latitude and longitude of the City of Oakland's new observatory, which must be known as a base for all future observations, Mr. G. V. Tudhope was requested to provide radio apparatus so that the time signals from the United States radio station at Mare Island, some 25 miles distant, could be received and used as an aid in these and other observations.

The large dome of the observatory is constructed of sheet metal and made to revolve upon an iron track, about 45 feet above the ground, by flexible steel cables driven by an electric motor on the first floor. Having noted that the dome, motor and steel cables were sufficiently insulated from the ground by the plaster boarded frame walls and wooden floors, and not wishing to mar the scenic beauty of the observatory and its surroundings by the erection of a radio mast, the metal dome of the observatory was used as the antenna. An ordinary two-slide tuning coil with silicon detector, small condenser, and 2,000 ohm receivers, were connected in the regular way to the steel cables leading in from the dome and to a 1-inch galvanised iron pipe driven about 8 feet into the ground, with the result that the radio time signals came in sufficiently clear and loud enough to be heard 2 feet from the receiver.

Professor Charles Burckhalter, Director of the Observatory, is an ardent advocate of radio receiving sets as permanent fixtures in all places where astronomical observations are made.

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Remarkable long-distance transmission by amateurs appears to be common in the State of Wisconsin, says the *Scientific American*. Recently E. H. Hartnell, an amateur of Salem, was able to work 75 miles either day or night with a 3-inch spark coil consuming 24 watts. Previous to this time the amateurs of California were looked upon as having a monopoly on long-distance transmission and reception with ordinary apparatus.

* * * * * *

Completion of San Diego station marks the welding of the third link in a chain of five wireless stations for the United States Navy, extending from Washington, D.C., to Cavite, P.L., *via* the Canal Zone, Panama. The new station has three towers each 600 feet high, and it is to operate in conjunction with the two stations already in service at Washington and Panama, and with the proposed station at Pearl Harbour, Honolulu. The latter, when realised, will connect the Philippines with the United States.

* * * * * *

President Wilson was steaming up New York Bay in the yacht *Mayflower* when he received confirmation of his re-election. It reached him in the form of a congratulatory wireless message from his secretary, Joseph P. Tumulty, who was in Long Branch, N.J.

Mr. Tumulty had told the President he would not congratulate him until it was definitely known that he was elected. When the result was no longer in doubt, he sent the news by wireless.

* * * * * *

R. R. Buck, navy radio operator on the Diamond Shoal lightship, was taken suddenly ill recently and sent out a wireless call for help. The destroyer *Cushing* was sent from the Norfolk navy yard with a physician and a substitute operator.—*Telegraph and Telephone Age.*

* * * * * *

On Saturday night, December 2nd, the Statue of Liberty was permanently flood-lighted at a wireless signal from President Wilson, who had come to New York for the ceremonies.—*Electrical World.*

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West Africa.

A wireless station has been erected on Cape Juby, on the African coast. It will be available for ships in distress. It is about 100 miles from the station on Teneriffe island.

R.M.S.P. Pocket Diary

The Royal Mail Steam Packet Company, of London, have again issued their customary Pocket Diary.

This year it contains four photogravures from paintings by Charles Dixon, R.I., of the company's vessels in the service of the Government from the Crimean War of 1854 to the present conflict.

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Instructional Article

NEW SERIES (No. 18).

The following series, of which the article below forms the eighteenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time

110. In a given circle to draw any number of circles touching one another and also touching the containing circle.

First divide the circumference of the given circle (Fig. 100) into as many equal parts as there are to be contained circles (in this case three). This can be done by using the construction of Fig. 95. Let *A*, *B* and *C* be the points of division, and let *O* be the centre of the circle.

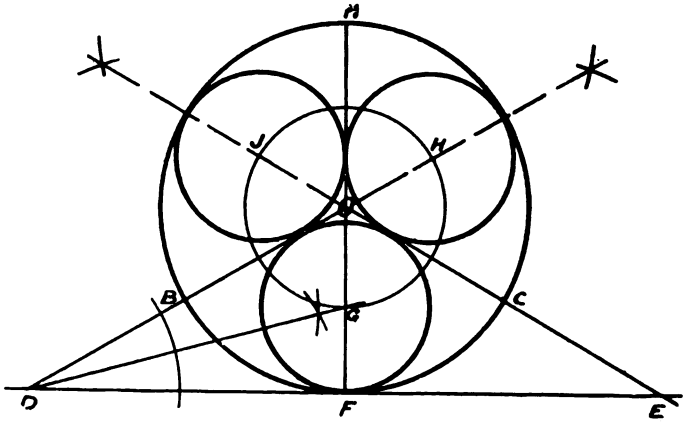

FIG. 100.

Draw the three radii, *OA*, *OB* and *OC*.

Bisect the angle *BOC* with the radius *OF*, and at *F* draw a tangent to the circle (which *must* be at right angles to *OF*), this tangent cutting *OB*, produced, and *OC*, produced at *D* and *E* respectively.

The problem now resolves itself into inscribing a circle in the triangle *ODE*, and then reproducing this circle in each of the other sectors of the big circle—*AOB* and *AOC*.

Therefore bisect the angle *ODE* with the line *DG*, cutting *OF* at *G*. Then *G* will be the centre and *GF* the radius of the first of the required circles.

To obtain the centres of the other circles draw a circle *GHJ*, with centre *O*, and radius *OG*, and bisect the angles *AOB* and *AOC* with the lines *OJ* and *OH*. Then *J* and *H* will be the centres of the other circles, the radii being, of course, the same as that of the first circle.

111. About a given circle to draw six equal circles touching one another and the given circle.

This is a very simple problem.

From centre *O* of the given circle (Fig. 101), draw any convenient radius *OA*. Produce *OA* to *B*, making *AB* equal to *OA*. With centre *O* and radius *OB* draw a second circle.

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Divide the circumference of this outer circle into six equal parts, and from each point of division draw a circle with a radius equal to *OA*.

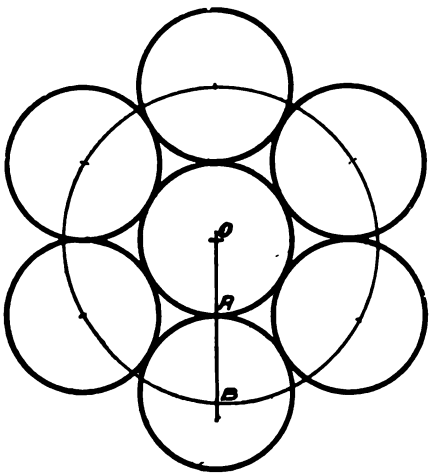
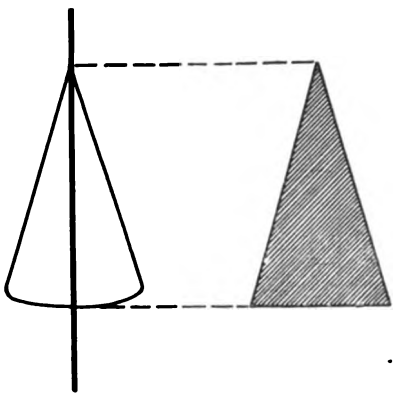


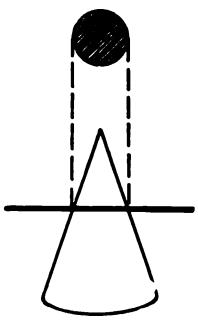
FIG. 101.

Fig. 100 and Fig. 101 show the cross-section of cables consisting, respectively, of three strands and seven strands.

It will be noticed that in seven-stranded cable there will be the same central strand along the whole length of the cable, the other six strands being coiled side by side round it. As the outer strands have a twist, we see that the central strand will be shorter than the others, all the latter being of equal length (for a straight length of cable).

Another point is this : if the frequency is high enough (as in wireless) the current will not penetrate into the inner conductor at all, and so the central strand is just so much waste copper. Copper being expensive, it will be cheaper to wind the six outer strands (or any other number) round some non-conducting core, the latter being made of any cheap — and suitable — material.



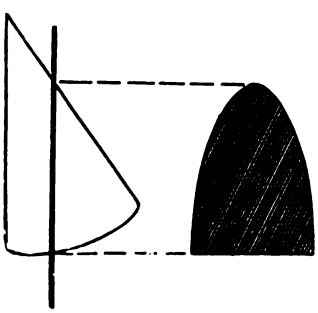


CONIC SECTIONS.

112. By the term conic section we mean the sectional shape obtained when a cone is cut by a plane. Five general forms are obtained in this manner :—

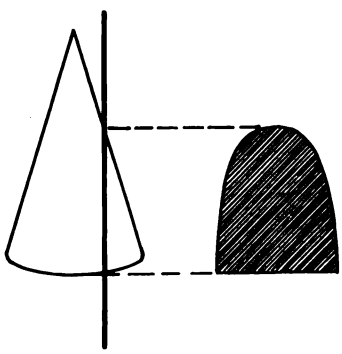
(1) *A Triangle*, when the plane cuts the cone along its axis.

(2) *A Circle*, when the plane cuts the cone perpendicular to its axis.



(3) *A Parabola*, when the plane cuts the cone parallel to one side.

(4) *A Hyperbola*, when the plane cuts the cone either perpendicular to its base or else



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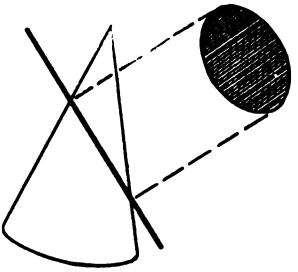
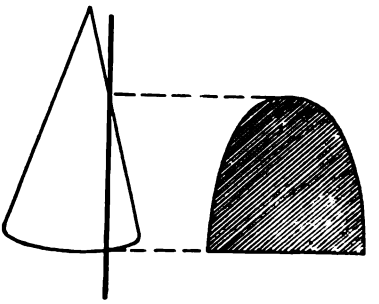


inclined to the axis at a smaller angle than the side of the cone.

(5) *An Ellipse*, when the plane cuts the cone obliquely, and without cutting the base.



The complete study of these latter curves would carry us far beyond the scope of these articles, and so all that will be given here will be a few methods for drawing them.

113. *Parabola.*—In Fig. 102 is shown the construction of a parabola on the base *AB*, and with the axis *CD*.

First complete the rectangle, *ABEF*. Then divide both *AC* and *AF* into the *same number* of equal parts—in this case six—numbering the points of division from *A*, as shown.

Through each point of division on *AC* erect perpendiculars, and join *D* to each point of division along *AF*. The points of intersection of correspondingly numbered lines will be points on the required parabola, and a fair curve drawn through them will give one half of the parabola. The other half is obtained in the same way.

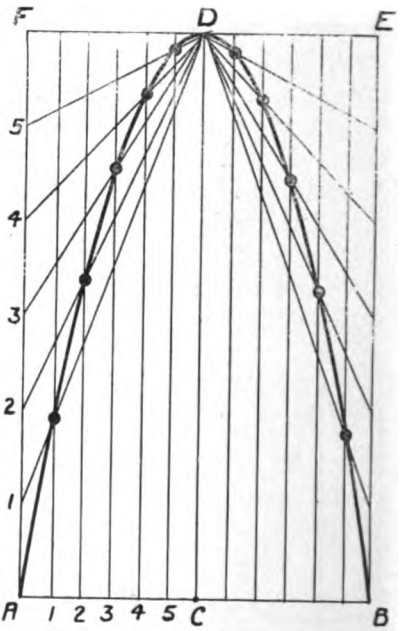


FIG. 102.

114. *Hyperbola.* — The most useful form of this curve is the *rectangular hyperbola*, the construction of which is shown in Fig. 103.

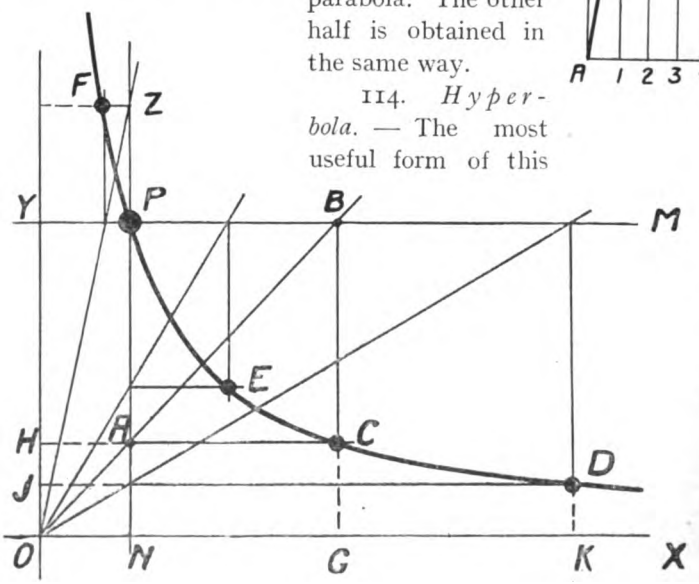


FIG. 103.

In this figure, *OX* and *OY* are the two perpendicular containing axes, and *P* is a known point on the hyperbola. Through *P* draw *ZN* parallel to *OY* and *YM* parallel to *OX*.

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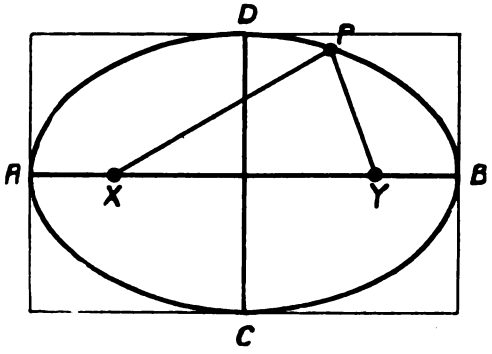

FIG. 104.

it will gradually approach, but never cut, these lines.

(*b*) If we take any point on the hyperbola, and complete a rectangle by using parts of *OX* and *OY* as two sides, *O* and the point taken being opposite corners; then, wherever we take this point, the area of this rectangle has the same value. Referring to Fig. 103, we can write—

$$OH \times OG = OY \times ON = OJ \times OK = \ldots$$

115. *Ellipse.*—An ellipse has two unequal diameters—*AB* and *CD* (Fig. 104)—perpendicular to one another. The longer diameter, *AB*, is known as the *major axis*, and the shorter diameter, *CD*, as the *minor axis*.

Then from *O* draw any line, *OB*, cutting *ZN* at *A* and *YM* at *B*. A perpendicular from *B* cuts a horizontal from *A* at *C*, where *C* is a second point on the hyperbola. In the same way the points *D*, *E* and *F* are found, and when we have sufficient points it only remains to draw a fair curve through them, as shown.

This curve has two simple properties—

(*a*) It is *tangential* to *OX* and *OY* —*i.e.*, if extended in both directions

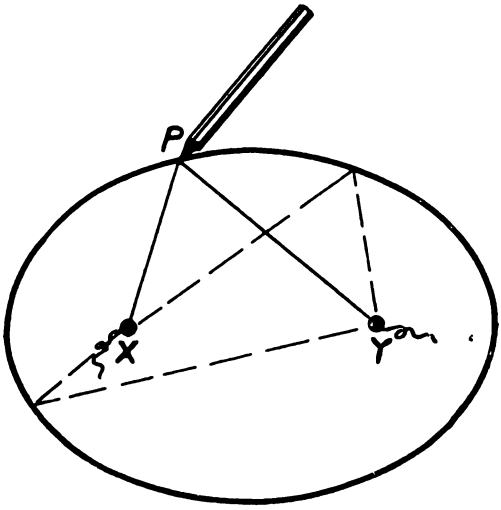

FIG. 105.

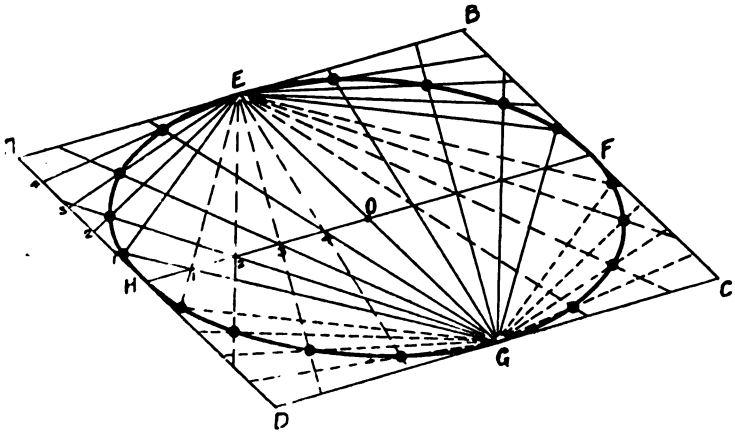

FIG. 106.

There are two points—*X* and *Y* —on the major axis, known as the *foci* of an ellipse. These are such that if any point, *P*, be taken on the circumference of the ellipse, then the sum of the radii, $PX + PY$, will be a constant quantity for any position of *P*.

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This property gives us the simplest method of drawing an ellipse: select two foci, X and Y (Fig. 105), and fasten a piece of string, XPY, of convenient length to pins at X and Y. Place the point of a pencil in the loop so formed and move it round, keeping the string taut. The pencil will trace out an ellipse.

Another method is similar to that used for a parabola.

In Fig. 106 we have a parallelogram, $ABCD$; this can be a rectangle if required. Each side of the parallelogram is bisected, and the points E, F, G and H so obtained are joined across as shown, thus subdividing the parallelogram into four equal parallelograms. Let O be the centre of the figure. OH and HA are divided into the same number of equal parts (in this case four), and the points of sub-division are numbered from H in each case.

E is joined to each point along HA, and G to each point along HO. The latter lines are produced to cut the former, and the points where correspondingly numbered lines cut will be points on the required ellipse.

In the same way the remaining parts of the ellipse can be constructed.

EDITORIAL NOTE.—*This concludes the present series of Instructional Articles. An announcement regarding a new series will appear next month.*

Wireless in the Tropics

With the Rhodesians in German East Africa

Photo: Topical.

This photograph shows a field wireless outfit with mast, aerial, and receiving and transmitting apparatus. This outfit was of long range and enabled the column to keep in touch with Brigadier General Northey in command of the southern forces.

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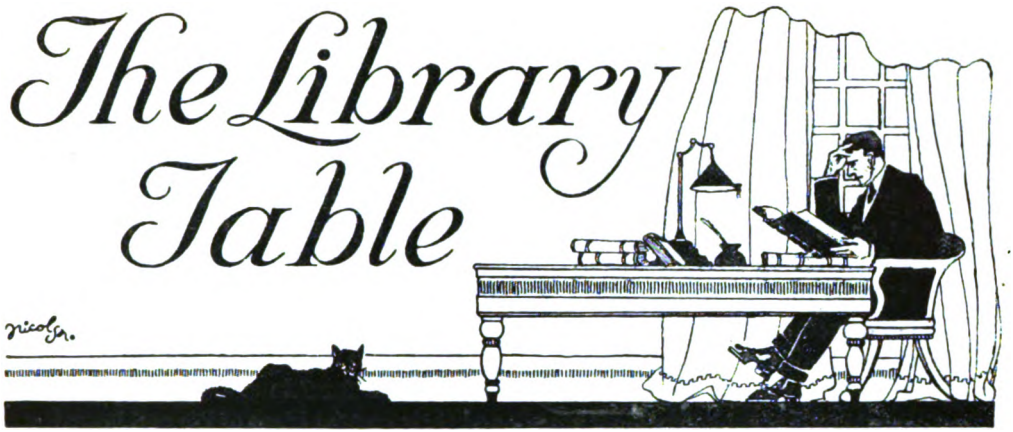
The Library Table



"AN OUTLINE OF THEOSOPHY." By C. W. Leadbeater. London: The Theosophical Publishing Society. 1916.

The doctrine of Theosophy contains some beautiful truths, some spurious science and a fair quantity of utter nonsense. Perhaps we shall not be far wrong if we define it as an attempt to gather together the main points of all religions and creeds (not excluding spiritualism) and then to apply to them some of the American ideas of efficiency. In an attempt to explain everything it makes little appeal to the average man, who consciously or unconsciously feels that if the system of the universe is brought within his own limited comprehension it must be a very poor thing indeed. This little book explains as well as any we have seen the faith of the Theosophists, and in perusing it very carefully we are only confirmed in our previous ideas. It is crammed full of definite assertions with nothing to back up, and when the author seems to have a doubt as to whether his readers will believe them, he makes such statements as that found on page 36, when, in referring to certain points, he says: "Once more we must repeat that all this is by no means "metaphysical speculation or pious opinion, but definite scientific fact thoroughly "well known experimentally to those who have studied Theosophy." This statement is made in connection with the previous paragraph, which contains the following assertion: "It might be said that there exist around us a series of worlds one "within the other (by interpenetration) and that man possesses a body for each of "these worlds, by means of which he may observe it and live in it." If this is a "definite scientific fact thoroughly well known experimentally" to Mr. Leadbeater and his fellow Theosophists, it is rather strange that some kind of convincing evidence on the point is not included in this book.

There is a great deal of talk in the little volume regarding "vibrations." Thus, on page 10 we find the following extraordinary statement: "The whole scheme will "be found fully explained in other theosophical works; for the moment let it "suffice to say that it is entirely a question of vibration. All information which "reaches a man from the world without reaches a man by means of vibration of "some sort, whether it be through the senses of sight, hearing or touch. Conse-"quently if a man is able to make himself sensitive to additional vibrations, he will "acquire additional information, and he will become what is commonly called a "clairvoyant."

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On page 38 we find some more pseudo-scientific announcements: "Recollect "that all matter is in essence the same. Astral matter does not differ in its nature "from physical matter, any more than ice differs in its nature from steam. It is "simply the same thing in a different condition. Physical matter may become "astral or astral may become mental, if only it be sufficiently sub-divided, and "caused to vibrate with the proper degree of rapidity." And again, a little farther on: "The appointed method for the evolution of the man's latent qualities seems "to be by learning to vibrate in response to impacts from without." Mr. Leadbeater and his fellow-disciples may be vibrating at a very high frequency quite comfortably, but we think most people would require a far more forcible shaking up than this book would give them before they abandoned their present ideas of life and hereafter.

* * * * * *

"SPONS' ELECTRICAL POCKET BOOK." By Walter H. Molesworth, M.I.E.E., M.I.M.E. London: E. & F. N. Spon, Ltd. 6s. net.

This collection of general electrical information, formulæ and tables for practical engineers, brought together in the form of an excellent pocket book by Mr. Walter H. Molesworth, will be welcomed wherever the need for such information is felt. Great care has been exercised in the selection of the material, and the author has wisely confined himself to those subjects which can be adequately dealt with within the confines of a handy book. For this reason we find no reference to telegraphy, telephony, and special branches of electricity, and many of the lengthy mathematical tables which add so much to the bulk of many so-called pocket-books will here be sought in vain.

It must not be thought, however, that the book suffers through the omission of these points. Quite the reverse is the case. With adequate space to deal with matters of importance the author is able to produce a volume which can be truly termed indispensable.

The many illustrations which elucidate the text are clearly drawn and excellently reproduced. As an example, nothing could be clearer than the manner in which details of electric railways, and the methods of support of catenary wires are explained in the section devoted to railways. The illustrations of electric locomotives of various types are particularly praiseworthy. Electric traction occupies a considerable portion of the book, and the matter relating thereto is thoroughly up to date.

The wireless man will turn with interest to the section devoted to alternating current circuits, generators, motors, etc., and will find the notes on transformers not without value. Altogether this book is well written and excellently produced. We have no doubt that it will rapidly find its place on the bookshelves of all practical engineers.

* * * * * *

"THE ELEMENTS OF ENGINEERING DRAWING." By E. Rowarth, A.M.I.E.E London: Methuen & Co., Ltd. 3s. net.

This book will be found very useful to students who are taking preliminary engineering courses in junior technical institutes. It should also appeal to operators who wish to learn how to draw their apparatus—and any improvements which may occur to them—in the best and clearest fashion. Commencing with a few notes on equipment, the author explains certain geometrical constructions which

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it is necessary that the student should understand before proceeding to more advanced work. In this section of the book the left-hand page of every opening is utilised for illustrations. Section 2 is given up to the study of orthographic projection and section 3 to a detailed consideration of the manner of drawing nuts, bolts, etc. Too much attention cannot be given to details of this sort, for, as the author says, unless they are carefully drawn with a moderate degree of accuracy the appearance of a drawing will be offensive to the eye of an engineer. In section 4 the more difficult work is described.

By carefully following out the instructions given in this book the student should make very good progress in what is certainly one of the most important branches of engineering study. There appears to be no superfluous matter and a great deal of real technical information is condensed in a small space. It should be mentioned that the exceptionally thick paper on which the book is printed makes it appear to contain much more matter than is actually the case.

* * * * * *

"THE COCONUT PLANTER." By D. Egerton Jones. London: Cassell & Co., Ltd. 6s.

When, in a novel, we find the heroine under the erroneous impression that she is a widow, and when, furthermore, she sets off from Australia to a Pacific Island on a steamer where at least one of the officers is handsome and fascinating, we know that something is sure to happen.

Sunny Shale, who is supposed to tell the story in the book before us, is a vivacious, excitable girl who had secretly married a wireless operator just prior to his departure for a distant wireless station in the Pacific. In this case, it seems, absence did not make the heart grow fonder, for Terry, the operator in question, wrote fewer and fewer letters to his wife as time went on, until at last the correspondence ceased entirely and a laconic message soon afterwards announces his death.

We should spoil the interest of the story for our readers if we were to tell how, thinking her husband was dead, the girl set forth from Australia to earn her living as a coconut planter on one of the islands in the Pacific and how, later, she suddenly became aware that her husband was still alive.

The characters in the book are clearly drawn and there is plenty of excitement for all who love a breezy, modern novel. Wireless crops up here and there, and several of the passages referring to this form of communication indicate that the author, unlike so many novelists, is not unacquainted with its technique. As a means of whiling away the hours off watch, or some idle time in port, this book can be confidently recommended.

Share Market Report

LONDON, *January 15th*, 1917.

Business has been very quiet in the Share Market during the past month, but there has been a considerable demand for all the issues by small investors.

Prices as we go to press are: Marconi Ordinary, £2 13s. 9d.; Marconi Preference, £2 5s.; Marconi International Marine, £1 19s. 6d.; American Marconi, 15s. 6d.; Canadian Marconi, 9s.; Spanish and General Wireless Trust, 9s. 6d.

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Personal Notes

MR. N. M. MACLACHLAN, whose biography and portrait appeared in our December issue, has now obtained the degree of Doctor of Science.

* * * * * *

We learn from the *London Gazette* that the King has been pleased to give orders for the publication of the names of Wireless Telegraph Operator R. C. Older and Wireless Telegraph Operator John Rea, in the *London Gazette*, as having received an expression of commendation for their services. We heartily congratulate these gentlemen on the honour they have received. Some notes regarding Messrs. Older and Rea have already appeared in our pages. Mr. Older was referred to "Among the Operators" for June last, and the story of Mr. Rea's adventure appeared in our issue for August, 1915.

* * * * * *

Members of Marconi's Wireless Telegraph Company, Limited, will deeply regret to learn that Mr. Arthur E. Johns died on December 17th, after a comparatively short illness. He was compelled to give up his duties in the Anti-Aircraft Corps last October, owing to ill-health. Probably the night duty last winter started his illness, which developed into an affection of the lungs.

* * * * * *

Señor Enrico Perez, editor of *El Marconigrama* and *O Marconigrama* (the Spanish and Portuguese editions of THE WIRELESS WORLD), will lecture at the King's College, London, at 5.15 p.m. on February 15th, on "England's Political and Economical Influence on Latin America." Señor Perez, who is intimately acquainted with all matters pertaining to the political evolution of Latin America, is giving this lecture by special request of Dr. Burrows, Principal at the College. Tickets may be obtained on application to the Secretary, King's College, London, W.C.

MR. BEGIN.

* * * * *

The first graduate of the Canadian Company's School of Instruction obtained his Government Certificate on November 20th and was immediately assigned to ship duty. Mr. Begin (not an inappropriate name for the holder of diploma number one !) is now on a three months' voyage, which should provide all the excitement he expressed himself as being so anxious to encounter.

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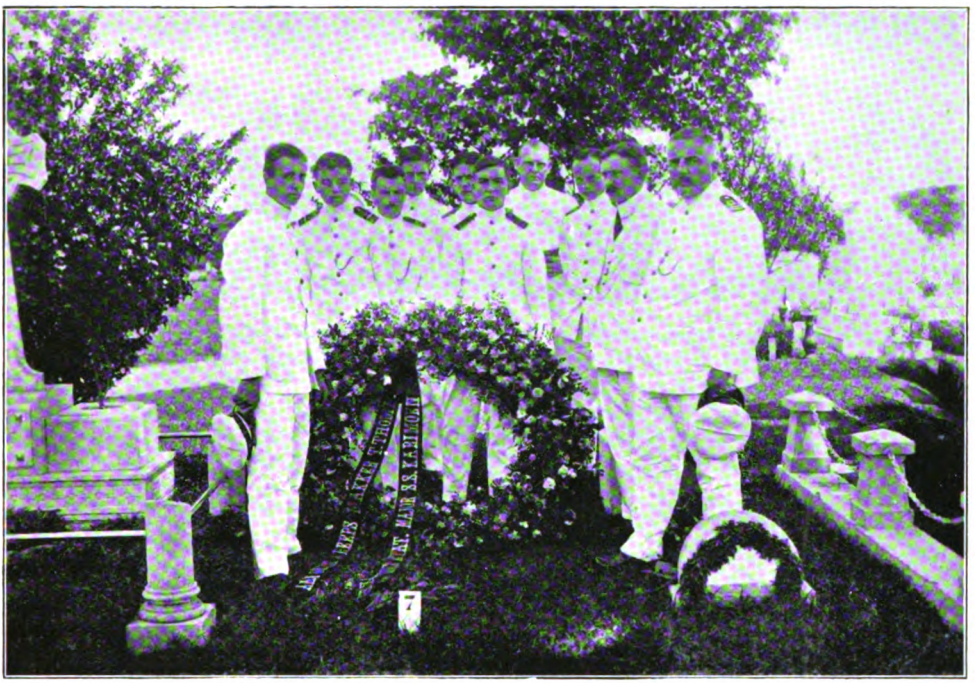
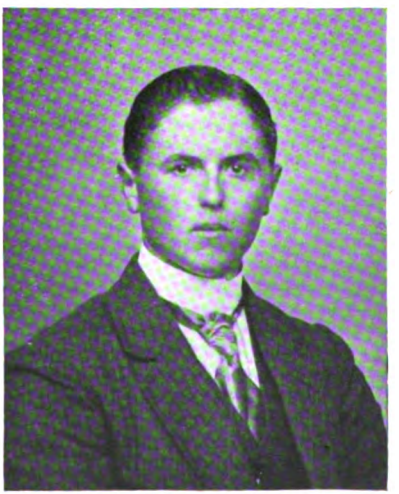


THE GRAVE OF THE LATE OPERATOR THOMA.

Wireless Operators in the Société Anonyme Internationale Télégraphie Sans Fil are deeply grieved at the loss of their confrère, T. Thoma, who died of dysentery at Manila last year. At the time of his illness Mr. Thoma, who was a native of Holland, was the wireless operator in charge of the Netherlands steamer *Karinaen*. The photograph, which we reproduce on this page, shows the grave of the late Mr. Thoma at Manila. The late operator's fellow officers are seen standing by the grave with a wreath presented by the ship's company. The late Mr. Thoma is seen in the small photograph.

* * * * *

Mr. W. A. Winterbottom has been appointed Division Superintendent of the Pacific Coast Division of the Marconi Wireless Telegraph Company of America, with headquarters at San Francisco. Mr. T. M. Stevens, who has been appointed Marine Superintendent of the same Company at San Francisco, will have charge of all matters pertaining to the operation of Coast Stations, including personnel in the Marine Service. Mr. M. E. Morris has been appointed Superintendent of the Southern Division, with headquarters at Baltimore, in the place of Mr. T. M. Stevens, who has transferred to the position above mentioned.



THE LATE MR. THOMA.

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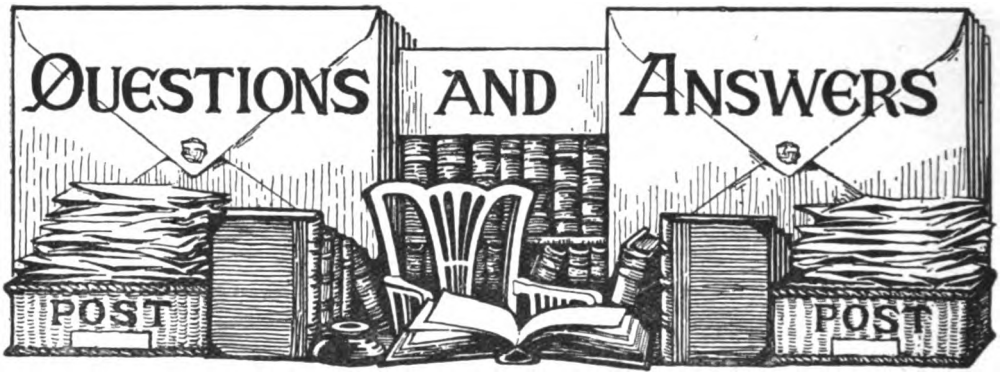

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

T. C. H. (Herne Hill).—Apply to Officer-in-Charge, Royal Naval Air Service, Wireless Section, Wormwood Scrubbs.

C. W. (Devonport).—See our article entitled "Operating in the Marine Service" in the January issue.

E. W. J. (Broadstairs) inquires the cost of entering the Marconi Company's service after the Postmaster-General's Certificate has been obtained. As this is a matter which interests a large number of our readers, we give a few notes on the subject herewith. It is impossible to say in so many pounds, shillings and pence how much an operator must spend after obtaining his P.M.G. Certificate, as much depends upon the demand for operators at the time. Provided there is a vacancy and the applicant is asked to call for a test at Marconi House, there will be first of all the travelling expenses to London, and, if he comes from a distant part, the cost of stopping in town for the night. If he is accepted there will be one guinea for the doctor's fee, the cost of the uniform and outfit, and the cost of living in London until he has completed his finishing course in the Marconi School. With the present demand for operators a man with a Postmaster-General's Certificate is most unlikely to stop in London more than a week, or ten days at the very outside, before appointment to a ship, and frequently the period is much shorter than this. The cost of board and lodging in London varies, and depends, of course, entirely upon the student's tastes. It should be remembered that while he is in the school the student will receive a salary of £1 per week, which will go towards his expenses.

SPARKS (R.F.C.).—We cannot give any information regarding wave-lengths or details of circuits for reception during the present restrictions.

H. H. (B.E.F.).—It is not possible to pass the Postmaster-General's Examination by postal tuition alone. A great deal may be learnt by correspondence and, provided the lessons are carefully followed, enough theory should be acquired to pass the theoretical test. Actual handling of the apparatus, however, is absolutely essential before going in for the examination, and the time taken to acquire this part of the knowledge depends entirely upon the student's abilities. If you were thoroughly acquainted with theory telegraphy and the reception of signals in the telephone headpiece it is possible that practical instruction for two or three weeks might enable you to pass; but we are inclined to think that this is the very shortest period in which it could be accomplished. If this answer should meet the eye of a student who has studied wireless by correspondence and passed the P.M.G. Examination after a shorter period of practical instruction than this, we should be glad if he would write and give us particulars.

A. W. I. (Aberavon) asks what is the highest wage obtainable as a Marconi operator and what is the average wage paid by the Telefunken Company to their operators. In reply to the first question, in peace times the highest wage obtainable by a sea-going operator who does not hold some other post as well, such as travelling inspector, is £2 15s. per week, with all found on board ship. It is not possible to

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state the highest wage paid to a land station operator, as this depends entirely upon the locality of the station and the man's experience and skill. We cannot give any particulars of wages paid to the Telefunken Company's operators, the German mercantile fleet being conspicuous by its absence at the present time.

A. B. (Killamarsh).—You will find all your questions answered in the article in our January number entitled "Operating in the Marine Service."

M. H. I. (Chelmsford).—Your question being of a constructional nature cannot be answered at the present time.

S. A. (Mullingar).—The explanations regarding "phase" and "angle of lag and lead," given in *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, should be quite sufficient to make the matter clear to you. Have you studied the first part of the book carefully? We would advise you to read through the explanations again, and if they are still not clear to you write to us again, stating exactly the points that present difficulty. It is not possible for us to deal with these matters in the "Questions and Answers" columns unless we know how far you understand the theory of alternating current. It is just possible that there may be a *Wireless Diary and Note Book* left by the time this issue is published, and if you apply at once you may be lucky enough to obtain one. There has been a tremendous demand for these useful books.

F. R. E. (Oban).—We are sorry to say that the fact that you have an artificial foot would debar you from employment in the marine operating service of the Marconi Company.

B. G. A. (B.E.F.) is another correspondent who asks questions on wave-lengths of stations, their programmes and their call letters, etc. All the stations he mentions are being used for war work by the countries to which they belong, and we are therefore unable to publish any information regarding them.

E. J. P. (R.F.C.) asks our opinion on a wireless system which he has devised. Briefly, it consists of a transmitter which can be made to radiate 26 different wave-lengths by means of as many keys, and a receiver with 26 tuned circuits to respond to the waves from the transmitter. Each tuned circuit of the receiver would be connected to a detector in circuit with a relay which would in turn operate a key like that of a typewriter or some device which would disclose a letter of the alphabet. Thus, if one depresses the letter A on the transmitter, the receiving circuit tuned to the particular wave-length would respond and mark A. The letter B would only operate the B circuit on the receiver, and so on with the rest of the alphabet. A system such as that described is open to a number of objections, the first of which is that no one station would be allowed to monopolise 26 wave-lengths for its transmission. Secondly, problems of interference and jambing would be 26 times as bad as they are now, which is a disadvantage not to be ignored, to say the least of it. Thirdly, atmospherics would probably operate all the letters of the alphabet at once; and fourthly, it would be possible to obtain precisely the same results by much simpler methods. There is at least one telegraph transmitter which has a typewriter keyboard and which automatically translates the signs into the Morse code as the keys are depressed. Similarly, there are receivers which translate signals of the Morse code into typewriting. These instruments can be adapted to wireless telegraphy in certain circumstances when it is thought advisable.

W. J. L. (B.E.F.).—Candidates for employment in the marine operating staff of the Marconi Company must not exceed 25 years in age, and this rule is rigidly adhered to. In reply to your second question, as you have Bangay's and Hawkhead's books, you have available all the theoretical information necessary for passing the Postmaster-General's Examination. It is difficult to recommend further books for study without knowing the extent of your knowledge. If you have not already a good knowledge of alternating current work, we would recommend you to purchase *Alternating Current Work*, by W. Perren Maycock (price 6s., post free 6s. 5d.). You should also study as many as possible of the technical articles which have appeared in our pages. They contain much practical information unobtainable elsewhere and are carefully chosen to meet the needs of such as yourself.

"JIGGER" (Tewkesbury).—We are not able to pass any opinion on the wireless course of the College you mention. We would suggest that you write and obtain particulars from several and choose the one which appears to you to be best.

"STATICA" (B.E.F.).—We do not think the effect you mention would be obtained if the apparatus was in proper order.—Are you quite sure that all the connections are tight? Many thanks for your kind wishes.

A. MACC. (Glasgow) sends us a number of questions of which we can answer only four owing to limitations of space. (1) If our correspondent will read carefully the article in our October issue entitled "Naval and Military Wireless Telegraphists," he will see that the wireless operators in the R.N.V.R. to whom he refers were normally civilian wireless operators. Prior to the war a number of these were in the service of the Marconi Company, and some have previously served on board ship. Others have had previous land station experience. We have not heard of any cases where they have been promoted to commissioned rank. (2) A

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wireless engineer is a man with a theoretical and practical knowledge of electrical engineering as applied to wireless telegraphy. Such men are chosen from applicants who have a practical electrical experience and are specially trained for their work by the company employing them. In most cases they have not previously been operators. (3) Usually the wireless apparatus on mercantile ships is owned by the Marconi Company, who also employs and pays the operator. In most cases the inspectors are employed by the Marconi Company, although the Government have some inspectors of their own. (4) The operators on board ship are under the control of the captain and must obey his instructions.

A. C. (Paris).—(1) There are a number of receiving circuits at the present time with which continuous waves can be received as a musical note without any tikker or tone wheel. The note given can be adjusted at will. In the diagram to which you refer the note given is that of the difference in frequency between the circuit composed of the inductance coupled to the aerial and the condenser shunted across it, and the circuit made up of the same inductance the lead through S, B, round to the plate, across from the plate to the grid, and through the condenser to the inductance again. Question 2. The total resistance of the two telephone receivers in series should, where possible, be equal to that of the detectors to which they are used. Crystal detectors vary considerably in their resistance. Thus the resistance of the zincite-bornite combination is much lower than that of some specimens of carborundum. Further, some carborundum crystals are of much higher resistance than others. The valve detector has a very high resistance and a total for the two receivers of 8,000 ohms is not too high in this case. Question 3. In certain receivers the aerial tuning inductance is placed at right angles to the coupling coil in order that there may not be any inductive effect between them. Question 4. The only advantage of the condenser C1 in your diagram is to make the secondary circuit a tuned one. When it is in place it forms with the coupling inductance and the stopping condenser a circuit which must be tuned to the frequency of the aerial. It should, therefore, be made variable. Thank you for setting out your questions so clearly.

"APOLOGY" (Londonderry).—The reason that you received such a reply from the Marconi Company was not that they had no vacancies for operators, but that the Company make a rule not to engage men of military age without a certificate. As a matter of fact, there is a very great demand for wireless operators at the present time and there is likely to be for some months to come. If you had a certificate it is most likely that your application would receive immediate consideration. In reply to your second question, there are one or two schools in Ireland where wireless telegraphy can be studied and where the Postmaster-General's Examinations are held. For particulars of these see our advertising pages. It would be quite satisfactory to take a correspondence course and finish off your training at one of these places. In practically all cases the Marconi Company employs the wireless operator. In reply to your last question, the International Morse Code is used in the Postmaster-General's Examination and the candidate is required to understand both the full and abbreviated numerals.

A. F. H. (Bishop's Waltham).—Actually there would be a very small charge in the condenser, but it would not be sufficient to give an indication when the voltmeter was connected across the condenser terminal. If the dielectric of the condenser is not punctured and you still get sparking at the contacts this tends to show that the capacity condenser is too small for the purpose.

Queries from M. F. and one or two other correspondents are held over through lack of space.

SPECIAL NOTICE.

Readers will considerably facilitate the work of our Expert if they write their questions on one side of the paper only, and make their queries as clear and full as possible. Questions should be numbered for reference and should not exceed four.

APARTMENTS, special terms to Marconi Students *only*, 15 minutes by tube to "The Strand," good table, excellent references, 16/6 per week inclusive.—MRS. BARRY YORKE, 22 Hogarth Road, Earl's Court, London, S.W.

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Australasian Time Signals

By F·Basil Cooke F·R·A·S

For several years wireless has been used for the determination of longitudes where previously line telegraphy was in vogue. This application is of such vital and far-reaching importance that first of all it would be well to review some of the uses of accurate time signals, especially in the Southern Hemisphere and particularly in Australia.

In the first place, let us imagine ourselves at sea in a dangerous locality. Dangerous places are usually marked with lighthouses, but such a method of warning is inadequate in cases of fog. Before the captain can find out where he is situated he has to make two observations, one to determine his latitude and the other to find his longitude. Once having settled these he can point to the exact position of his ship on the earth. Whilst the finding of latitude is a very simple observation, the contrary is the case with longitude. Briefly stated, the longitude is the difference between the local time at the place and the time at Greenwich. The captain can easily determine his local time but has to depend on his chronometer for Greenwich time. It is easy to see, then, that if his chronometer fails or its rate varies he has no possible way of finding his longitude, and consequently does not know where he is. In fact, if his chronometer gains or loses four seconds he is one mile out in his reckoning, a situation more than serious in dangerous waters.

In the Northern Hemisphere there are several wireless stations which send out time signals twice a day, with the result that the ships' chronometers can be constantly checked. Until quite recently there were no stations transmitting time signals in Australasia, but Adelaide and Melbourne have now taken up the work at midnight and midday. All the other coast stations will shortly follow suit. These signals are always transmitted through a relay controlled by the Observatory clock, with the result that they are accurate to well within a quarter of a second. The reader will now be able to realise the importance to the mariner of exact time signals and how similar reasoning may be applied to land survey work. The surveyor has merely to erect a small portable set and pick up the nearest land station when he will have immediately the means of determining his longitude. The accurate reception of these signals is not nearly so easy as it sounds, and some of the difficulties and the means of overcoming them will be dealt with later.

In the compilation of the "Nautical Almanac" and other astronomical and geological works it is necessary to know the shape of the earth. The only satisfactory method as yet known is to survey the whole globe by means of chain and

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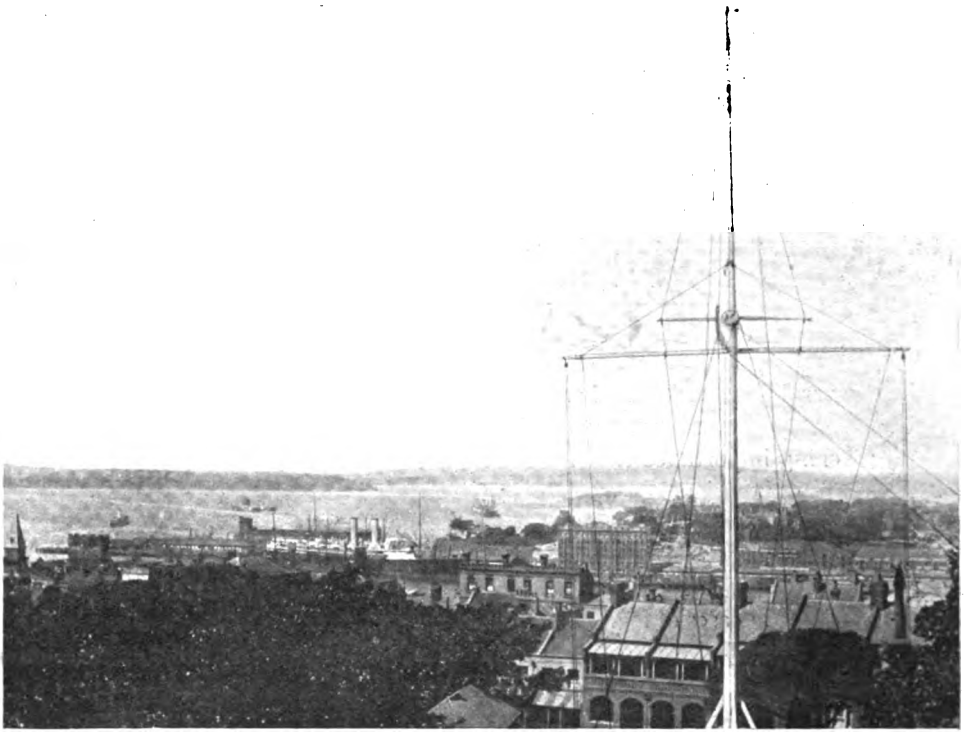

A VIEW OF SYDNEY HARBOUR FROM THE TOWER SHOWN ON PAGE 889. ON THE RIGHT IS THE FLAGSTAFF OF THE CENTRAL SIGNAL STATION. ON THE LEFT CAN BE SEEN THE SMALL ISLAND (FORT DENISON), FROM WHICH TIME IS DISTRIBUTED AT NOON BY GUNFIRE.

level. The importance of this survey has been so great that just prior to the war it was resolved to carry out a gigantic trigonometrical survey. In the Northern Hemisphere much work has been done, and all the principal observatories are linked up very accurately. In the Southern Hemisphere, however, there is very little land, thus making it much harder to survey. Australia has also the disadvantage of being far from the rest of the scientific world. It is expected that before long the Commonwealth Survey Department will carry out a trigonometrical survey of Australia, and if so it will probably be as accurate as any in the world.

We shall now see, briefly, how longitude determinations in the past have been attended with unavoidable errors, and how wireless has given us a means of eliminating some of the old errors by making it possible to carry out work in places where the sole means of communication is an occasional boat. We shall then see the importance of the scheme proposed by the New South Wales Government for charting the Islands in the Pacific.

In the past all the most accurate longitudes have been determined by means of either land line telegraphs or submarine cables. Before we can appreciate the advantage of wireless over the cable method it would be well briefly to consider how the cable is used and what errors are liable to occur. We shall entirely neglect

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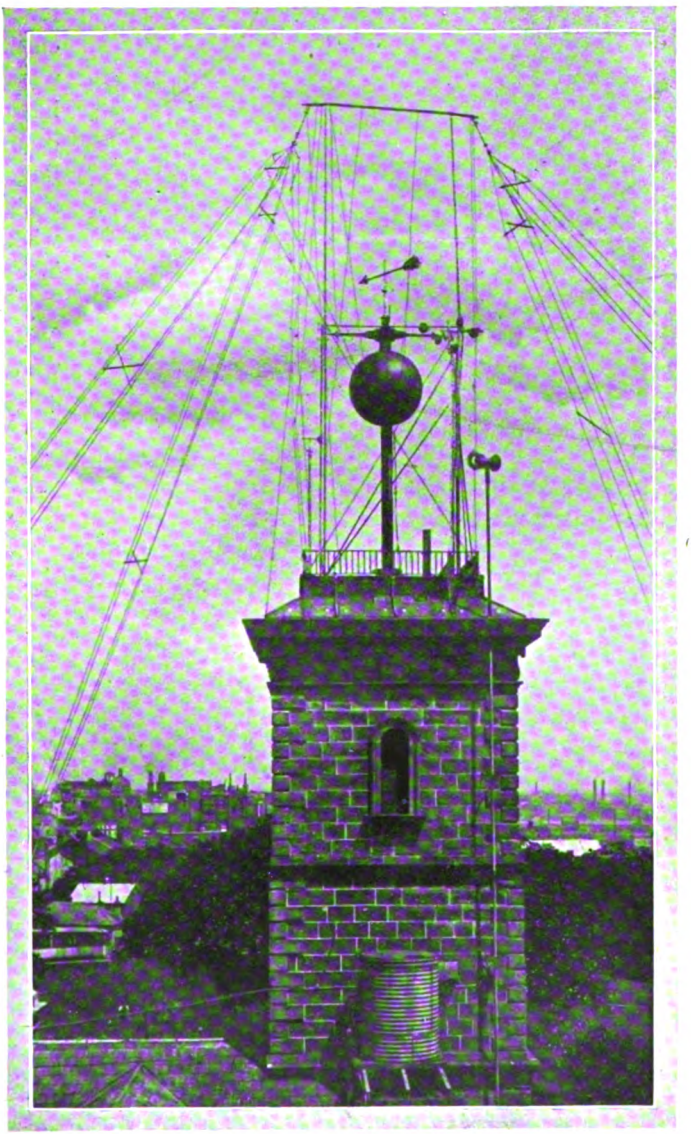
the astronomical side and concern ourselves only with the electrical part of th programme.

Let us take two stations, A and B. Suppose A be accurately fixed and B the station whose longitude we wish to find. At A the sidereal clock is connected to the cable and every second the contact is closed. The current then flows along the line to B. At B it closes a relay, which is connected to a chronograph and marks the seconds on this instrument. At B the local clock acts similarly. The difference in time between A and B can then be read off. At first sight this seems a very simple procedure and not likely to contain any errors. However, errors creep in as follows. First there is the time taken for the current to pass the clock contacts at A. Then we have the time occupied to saturate the coils of the relay. Next the current has to pass along the cable to B and saturate the coils of the B relay. This time is a very uncertain quantity and is almost impossible to ascertain. At B the current has to pass into and saturate the coils of the Pen relay on the chronograph. Further, the time lost in transmission is different for different lengths of cable.



THE SYDNEY OBSERVATORY TOWER, WITH TIME-BALL AND AERIAL. THE TOWER IS 50 FEET FROM THE GROUND, AND THE MASTS 30 FEET, MAKING A TOTAL OF 80 FEET FOR THE AERIAL. ON THIS ANTENNA SIGNALS FROM TUCKERTON, 10,000 MILES AWAY, WERE HEARD.

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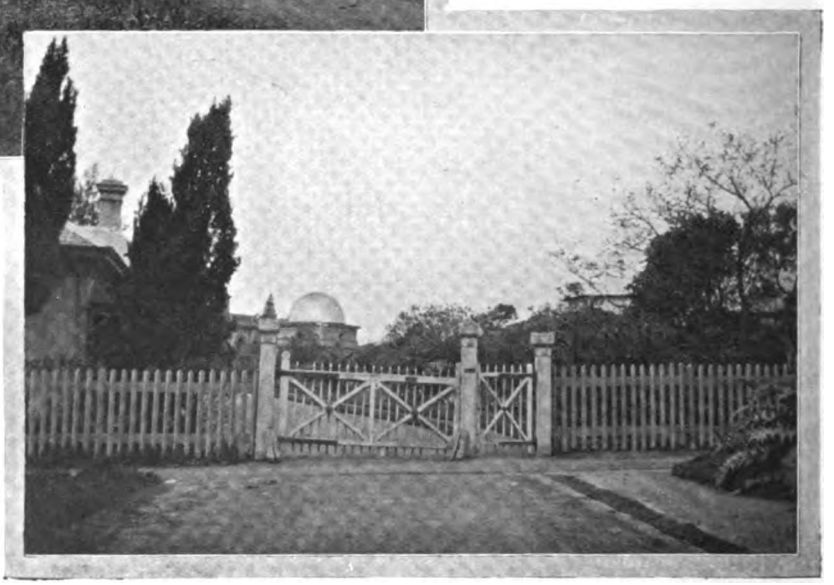
When B is very far from A further trouble arises, since there is a maximum distance over which the clock beats can pass without being relayed. Also the use of different relays and different adjustments of the same relays cause unknown variations in the amount of lag. Even with these many difficulties wonderfully accurate work has been done. As an instance we might cite the case of Sydney. Sydney was linked up with Greenwich by a series of steps from Greenwich both west and east. The final results were: Eastward, 10 hours, ·04 minutes, 49·355 seconds, and westward, 10 hours, ·04 minutes, 49·287 seconds, the difference

THE MELBOURNE WIRELESS STATION IN ITS BEAUTIFUL GROUNDS.



THE MELBOURNE OBSERVATORY, CONNECTED BY WIRE WITH THE WIRELESS STATION NEAR BY.

being 0·068 seconds, equivalent to a distance of only 84 ft. It has always been felt that this was a wonderful coincidence, but it is advisable to check these results by a

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[*Photo: Underwood.*

A VIEW IN TAHITI, WHERE THERE IS A POWERFUL WIRELESS STATION WHICH WILL TAKE ITS PLACE IN THE TIME SIGNAL SCHEME.

third and totally different method. Before leaving the cable method we must bear in mind the old saying that no chain is stronger than its weakest link. In other words, when we have to use several steps in going from A to B, every error in each successive link is added to the next and so on. We see then that when three or four links are necessary, the final error is quite likely to be noticeable, even though the errors in the separate links be quite small. Let us now see how wireless offers us a solution to our difficulties.

There are two methods open to practical use. The first is that which has been used between Arlington and Paris. Briefly it is very much the same as the cable method except that there are no cable troubles and links. Otherwise at the transmitting end the methods are similar. At the receiving end, instead of recording the signals on a chronograph they are heard together with the beats from the local clock in a telephone receiver. By means of the method of coincidences (described in any good book of physics) it is possible when the ticks are sufficiently sharp to determine the time of the received signals within one-hundredth of a second. There are still openings for error in this method, especially at the transmitting end. Further, the dots issued every second are usually so faint that it is probably the end rather than the beginning of the dot that is heard. This latter difficulty has been overcome by means of the photographic recorder, although in using this instrument one is liable to have trouble arising from interference, due to " static " and jamming.

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[*Photo: Un.'erwood.*

NATIVES OF SAMOA, ONE OF THE ISLANDS IN THE AUSTRALASIAN TIME SIGNAL SCHEME.

The second method is the one suggested for the South Sea survey. In this method a third station is used, preferably about halfway between the two stations concerned. Let us call this station C. C sends out signals (usually a series of dots evenly spaced with intervals of nearly, but not quite, a second), A and B both determine the local time of these signals by means of the method of coincidences and compare notes afterwards. It will be evident that all transmission errors will be greatly reduced. The main risk of error in this case is in getting very sharp dots. Experiments are being made at the present time with the assistance of the radio station at Adelaide, and already the results are promising. One of the advantages of the wireless method is that a number of observatories can receive the same set of signals simultaneously and thus determine their relative positions with greater accuracy than by former methods. In fact, this will also act conversely and the joint result of the mean distance between Australia and Greenwich will be correspondingly strengthened.

Before outlining the proposed scheme it would be well to see what equipment we have in Australia for the project. For several years it has been felt that it would be advisable for the radio stations to issue time signals at midnight and midday for the convenience of shipping. Already Melbourne and Adelaide are doing this with very satisfactory results. Perth, Sydney and Brisbane will shortly be following suit. The several observatories have, or shortly will have, their own wireless receiving stations and will check the out-going signals.

At the beginning of this article reference was made to the trigonometrical survey of Australia. At present this survey is only important to the Australians

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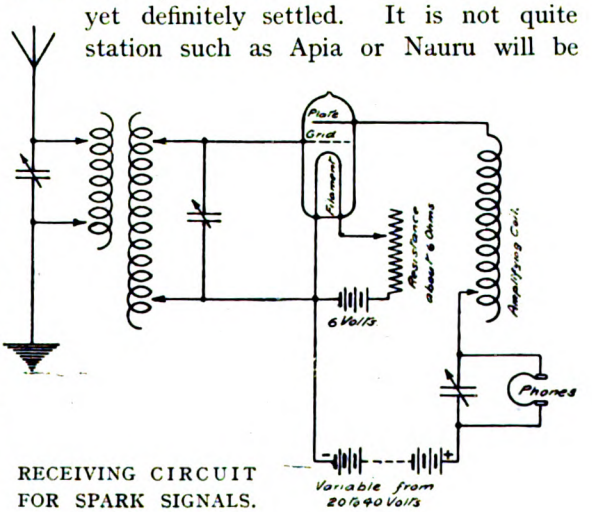
and will remain so until the position of some fixed station is definitely and accurately linked up with Greenwich. As soon as this is done, all our trigonometrical work will be of international importance, as it will make it possible definitely to place Australia on the map and so help to complete the general survey of the whole world.

Some few months ago the Surveyor-General for New South Wales proposed a scheme to the Government to extend this trigonometrical work to the South Sea Islands and thence to the other islands in the Pacific linking up with America, India and Japan. By means of wireless this survey could be carried on almost as accurately as the land survey. This would enable stations to be erected in the Pacific for issuing accurate time signals. At present this is impossible as the position of some of the islands is only vaguely known. Boats going to and coming from America have to rely absolutely on their chronometers, with the consequence that there have been a number of wrecks which might have been avoided had the scheme been carried out before this. The first work will be to link up Sydney with Honolulu, using the station at Nauru, a small island north of Sydney and nearly on the equator, as a central transmitting station. The installation at the Sydney Observatory can hear this station, as can also Honolulu. This will give a complete run through direct from Sydney to Honolulu, which latter place has already been linked up accurately with Greenwich. In this project the other Observatories at Melbourne, Adelaide and New Zealand will simultaneously fix their own positions. The second part of the programme will be to start from the east coast of Australia and work eastwards to the various islands, finally ending up at the American coast. All the different places where there are already wireless stations will be visited first. We might call this the major triangulation. Some of the suggested stations are Hobart, Adelaide, Melbourne, Sydney, Brisbane, Townsville, Awanui and Wellington in New Zealand, Suva (Fiji), Apia (Samoa), Chatham Islands, Tahiti, Nauru to Honolulu. After the major triangulation has been completed some of the other islands will be linked. This latter, or minor, triangulation will be carried out by means of a portable set. The officer in charge of the portable set will go from island to island linking up with one or other of the major points.

The final details are not yet definitely settled. It is not quite decided whether a central Pacific station such as Apia or Nauru will be chosen or whether the signals will be transmitted from Sydney. This point will be determined when we find out whether Sydney can be heard from all the different points. Experiments seem to show that this will be possible by means of an audion receiver.

One of the chief causes of error is that short dots will not carry so well as longer ones. This means that one is likely to observe the middle instead of



RECEIVING CIRCUIT FOR SPARK SIGNALS.

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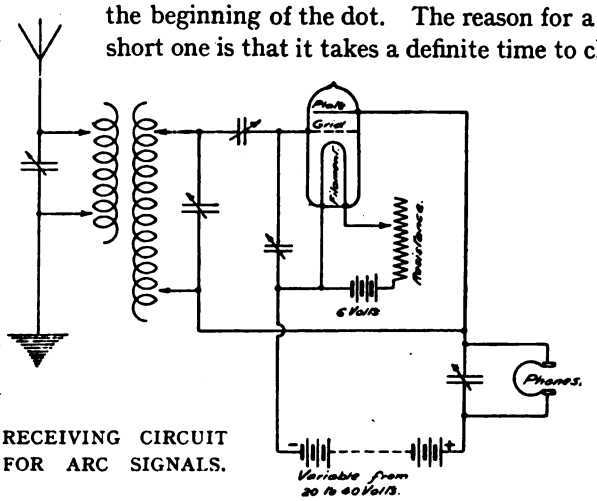
the beginning of the dot. The reason for a long dot carrying better than a short one is that it takes a definite time to charge the aerial fully. There are two suggestions open to eliminate this difficulty. The first is to send out a continuous sound broken at the correct intervals. In taking coincidences one must observe the silences instead of the beats. Obviously in this way the breaks can be as short as desired. The other method is to use continuous wave telegraphy. In this method a continuous wave is emitted and the dots are made by altering the wave-length. The latter method commends itself, as one can use the single dot or silence method at will by simply tuning to either of the two wave-lengths. Further, much longer wave-lengths can be used in arc work than in spark telegraphy for a given aerial. In spark work if one loads the aerial beyond a very small limit there is a great loss in the strength of the signals owing to reactance. In arc work, however, experiments seem to show there is practically no limit to the wave-length that can be used. It is a decided advantage to use long wave-lengths, as there is less chance of being jammed. Experiments are about to be made between Adelaide and Sydney on the silence method, also between Honolulu and Sydney on the arc method.



RECEIVING CIRCUIT FOR ARC SIGNALS.

Brief reference was made above to the audion receiver. It might be interesting to show what has been accomplished by the aid of the audion at our own station at the Sydney Observatory. The aerial consists of four squirrel cages 60 ft. long, each cage made up of four No. 14 S.W.G. hard-drawn copper wires. They are supported from a mast 80 ft. high and come down on the four sides at an angle of 45 degrees. The top ends are joined to four wires, which act as feeders and come down to the cabin at an angle of 30 degrees. On this aerial, using crystal, the greatest distance signals had been heard was from Nauru, a distance of about 2,500 miles. With the introduction of the audion signals can be comfortably read from Tuckerton, in New Jersey, a distance of about 10,000 miles. Several other American arc stations have been heard together with Honolulu, Japan, and even China. The wave-length used by Tuckerton was 9,000 meters. This necessitated a tremendous amount of loading. With Honolulu, 4,500 miles, we hear the big spark station readably and the arc station very strongly—both stations using the same power and a wave-length of 4,500 metres. This is an illustration of the loss in the case of the spark owing to loading.

Before concluding this article I wish to take this opportunity of thanking the many companies, private gentlemen, and different Government departments for the help they have tendered. In particular may I express my thanks to the American Marconi Company for the offer of the use of their station at Honolulu, the Federal

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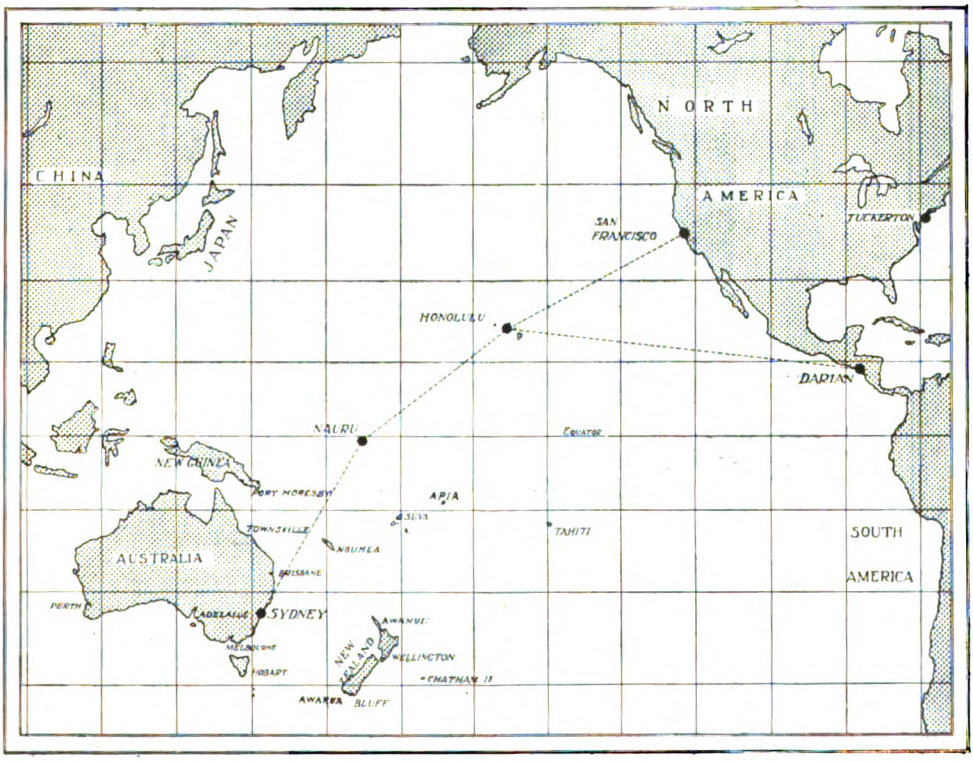
Telegraph Company for their arc stations at Honolulu and elsewhere, Lieutenant Creswell, the naval radio-telegraphic engineer of the Australian Commonwealth, for his kind interest (material and otherwise) in this work, the Amalgamated Wireless (Aust.), Ltd., for their assistance and advice, and many other private people who have placed their stations at our disposal.

The writer also wishes to thank anyone who will be kind enough to suggest anything in connection with this proposed undertaking.

In conclusion one might be forgiven for looking ahead into the dim mists of the future, where, without exercising undue imagination, we can see a great chain of wireless stations suitably positioned all over the globe, linking up the nations of the world as one whole, all striving for one end, irrespective of national differences. This furtherance of science will, we hope, help to bring about the great day when all peoples on this planet will work harmoniously together.

EDITORIAL NOTE

With reference to the above article, it has been recently announced by the Japanese Department of Communications that in future time signals will be sent out at 9 o'clock every evening (except Sundays) to all ships sailing within transmission radius of the Funabashi and Cosi wireless stations.



MAP SHOWING THE PROPOSED SCHEME OF TIME SIGNALS.

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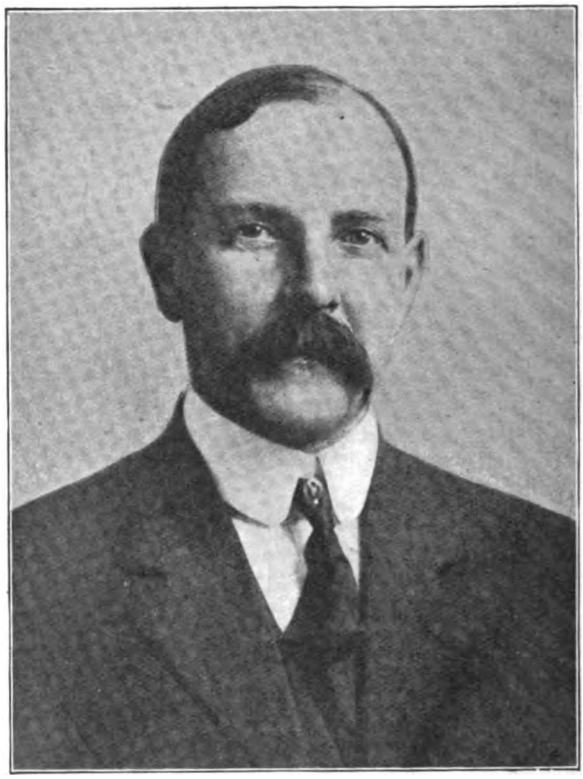
PERSONALITIES IN THE WIRELESS WORLD



PROFESSOR A. E. KENNELLY

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THE subject of our biography this month, Professor A. E. Kennelly, has had a varied and interesting career. Born in Calaba, Bombay, in 1861, he received his education in England, Scotland, France, Belgium and Italy. In 1875 he left school to become a telegraph operator in the Eastern Telegraph Company, and six years later became chief electrician on a cable ship. In 1886 he was appointed senior electrician of the ship's staff of the Eastern Telegraph Company, shortly afterwards becoming principal electrical assistant to the famous inventor, Thomas A. Edison, in his laboratories at Orange, N.J. After serving six years in this capacity, Professor Kennelly took up the profession of consulting engineer in Philadelphia, and from 1893 to 1900 worked in partnership with Mr. E. J. Houston, of the Thomson-Houston Company. Since that time he has undertaken some important work in connection with the laying of a cable from Vera Cruz to Campeche, and has held the position of Professor of Electrical Engineering at Harvard University and also at Massachusetts Institute of Technology. He is now Director of the Research Division of the Electrical Engineering Department of the latter institution.

In the world of wireless he is known as the President of the Institute of Radio Engineers for 1916, as the author of an important text-book on radiotelegraphy and of many scientific papers dealing with the subject.

Professor Kennelly has held many important positions on committees of various kinds and acted as Vice-President of the International Electrical Congress at Paris and Turin. He is a Corresponding Fellow of the British Association for the Advancement of Science, a member of the Institution of Electrical Engineers of London and Fellow of the American Academy of Arts and Sciences. In past years he has been Chairman and Secretary of the Standards Committee of the American Institute of Electrical Engineers and Secretary of the American Committee of the International Electrotechnical Commission. He has written 23 books as author and collaborator and is the author of more than 123 scientific papers. Professor Kennelly has specialised in alternating currents.

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An Outline of the Design of a Wireless Station

By BERTRAM HOYLE, M.Sc.Tech., A.M.I.E.E., Lieutenant R.N.V.R., H.M.S. "Excellent." 1917.

Introduction.

In the following article the author sets out the steps by which the dimensions of the various pieces of apparatus involved are calculated.

As a datum for starting, it is assumed that a minimum aerial current of 45 micro-ampères is required at the receiving end in order to give satisfactory signals. Much depends on the type and efficiency of the detector used, as to whether this figure is excessive or not; and as the whole design of the station, and number of K.W. installed at the transmitting end depend upon this figure, it must be carefully considered.

The above aerial current is ample to work a magnetic detector, with efficient tuning circuits; and is on the high side for circuits using crystal detectors and aural receiving. It is also sufficient to work an Einthoven string galvanometer for automatic receiving in conjunction with suitable crystal detectors.

In order to start the design, the distance between the two proposed stations must be known, and as the distance apart of two widely separated places cannot be measured from maps, two simple methods by which it may be accurately calculated are given.

For the present design it will be assumed that the two stations are situated, one at Carnarvon (North Wales), 53° 10′ N. lat. and 4° 15′ W. long., and the other at Cape Breton (Nova Scotia), 46° 0′ N. lat. and 60° 0′ W. long., the latitude and longitude being taken from Volume XXXV. of the *Encyclopædia Britannica*.*

Table of Symbols Used.

A = Correction function for insulation in inductance formula.
a = Radius of a coil, in cms.
B = Correction function for number of turns in inductance formula.
b = Breadth of coil, in cms.
D = Diameter, actual, or effective overall, in cms.
d = Diameter of conductor, in cms.
h = Height (unless otherwise stated).
I = Current intensity in ampères.
K = Capacity, in microfarads.
L = Inductance, in cms.
l = Length, in metres.
N = Spark train frequency (per second).
n = Oscillatory frequency (per second).
$p = 2\pi n$.
Q = Function used in Lorenz's inductance formula.

* Editorial Note: These are hypothetical stations and do not refer to any existing installations.

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R = Resistance.
R^1 = High-frequency resistance.
t = Thickness, in cms.
V = Voltage.
W = Watts.
X = Function used in Rayleigh's inductance formula.

α = Longitudes.
δ = Logarithmic decrement (per semi-period).
ΔL = Correction to inductance calculations.
η = Efficiency.
ε = Base of Naperian logarithms.
θ = Latitudes.
Cos φ = Power factor.
λ = Wave length, in metres unless otherwise stated.
ρ = Specific resistance = 1,640 for copper.

PART I.

1. *Distance Apart of Two Points on a Sphere.*—The shortest distance between two places on the surface of the earth is the distance measured along the arc of the great circle passing through those two points.

Knowing the latitude and longitude of the two places, *a* and *b* say, the problem resolves itself into finding the angle subtended at the centre of the earth by the arc of the great circle joining them.

Let θ be the latitude of station *a*;
θ_1 be the latitude of station *b*;
α be the longitude of station *a*;
α_1 be the longitude of station *b*;
and φ the angle subtended by the arc *a*, *b* at the centre of the great circle.

Then two formulæ are available:

$$\cos\varphi = \sin\theta\sin\theta_1 + \cos\theta\cos\alpha\cos\theta_1\cos\alpha_1 + \cos\theta\sin\alpha\cos\theta_1\sin\alpha_1$$

or:

$$\text{hav}\,\varphi = \text{hav}\,(\theta-\theta_1) + \text{hav}\,(\alpha-\alpha_1)\sin(90^\circ-\theta)\sin(90^\circ-\theta_1)$$

i.e., $\text{hav}\begin{pmatrix}\text{Difference in}\\ \text{latitude}\end{pmatrix} + \text{hav}\begin{pmatrix}\text{Difference in}\\ \text{longitude}\end{pmatrix}\sin(90^\circ-\theta)\sin(90^\circ-\theta_1)$.

Since all ordinary trigonometrical tables give natural sines and cosines, the first formula will be most generally convenient, though the second is obviously the shorter one of the two to work out.

2. *Distance between Carnarvon and Cape Breton.*—Using the first equation to find the angle subtended at the centre of the great circle joining the two stations

$$\text{Cos}\,\varphi = (0{\cdot}71934\times0{\cdot}80038) + (0{\cdot}69466\times0{\cdot}5\times0{\cdot}6\times0{\cdot}99738) + (0{\cdot}69466\times0{\cdot}866\times0{\cdot}6\times0{\cdot}074) = 0{\cdot}8100.$$

Whence $\varphi = 35^\circ\ 54'$.

By the second equation, using haversines:

$$\begin{aligned}\text{Hav}\,\varphi &= \text{hav}\,7^\circ\ 10' + \text{hav}\,55^\circ\ 45'\sin 36^\circ\ 50'\sin 44^\circ\\ &= 0{\cdot}00391 + 0{\cdot}21860\times0{\cdot}59949\times0{\cdot}69466\\ &= 0{\cdot}09491.\end{aligned}$$

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Whence $\varphi = 35^\circ\ 53'\ 35''$.

Taking the radius of the earth as 3,440 miles, then the distance apart of the two stations will be :

$$2\ \pi\ 3440. \times \frac{35{\cdot}9}{360} = 2{,}154 \text{ miles,}$$

or 3,467 kilometres.

[NOTE.—Occasionally where θ and θ_1 or α and α_1 are approximately equal, then a simple approximation may be made as follows, to the two equations given above :

$$\text{Distance} = \left(\frac{\text{Difference of long. of } a \text{ and } b}{360}\right) 2\ .\ \pi\ .\ 3{,}440 \cos \text{(mean lat.)}$$

$$\text{or} = \left(\frac{\text{Difference of lat. of } a \text{ and } b}{360}\right) 2\ \pi\ 3{,}440 \cos \text{(mean long.)}$$

but it should be noted that the mean latitude or mean longitude formula must only be used when those latitudes or longitudes are not very different. Since in the present example the latitudes are not very different, the approximate method might be made to serve.

Taking mean latitude to be $49^\circ\ 35'$ and difference in longitude to be $55^\circ\ 45'$, then distance is approximately :

$$d = \frac{55{\cdot}75}{360} \times 2\ \pi\ 3{,}440 \cos 49^\circ\ 35' = 2{,}170 \text{ miles}$$

which is quite a close approximation to the true value. For latitudes differing by greater amounts the divergence from the correct value becomes greater.]

3. *Determination of Aerial Current, Height, and Wave Length.*—Knowing now the distance apart of the two proposed stations, it is advisable to determine next the transmitting aerial current, height, and settle the wave length, and for simplicity it will be assumed that the two stations employ similar aerials for both transmitting and receiving.

Austin, in the *Bulletin of Bureau of Standards, Washington*, Volume VII., No. 3, gives the following formula connecting the transmitting and receiving aerial currents :

$$I_s = I_R \div \left[4{\cdot}25 \frac{h_1\ .\ h_2}{\lambda\ .\ d.}\ \varepsilon^{\frac{-0{\cdot}0015\,d}{\sqrt{\lambda}}}\right] \text{ ampères.}$$

where I_s = current in transmitting aerial in ampères ;
I_R = current in receiving aerial in ampères ;
h_1 h_2 = aerial heights in kilometres ;
λ = wave length in kilometres ;
d = distance between stations in kilometres.

The exponential term is the factor taking absorption into account ; and the numeral 0·0015 is empirical. Some experiments on absorption lead one to suggest 0·0015, whilst others seem to indicate that 0·0019 would more accurately represent the facts.

It should be remembered that at night time, this term may in certain regions approach unity, when I_s can be reduced very considerably.

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At present only I_R and d are known in this formula, and h_1 will be taken equal to h_2. The wave length λ, heights of aerial h and transmitting aerial current I_s have, therefore, to be settled simultaneously, and an infinite number of pairs of values of h and λ can be made to fit in with reasonable values of I_s.

Usually in practice a certain maximum value can be stated for h, whence the value of λ to give a reasonable sort of transmitting aerial current is found.

In this design the following values will be taken :

$h_1 = h_2 = 150$ metres or ·15 kms, and $\lambda = 3{,}000$ metres or 3 kms.

Whence
$$I_s = \frac{45 \times 10^{-6} \times 3 \times 3{,}467}{4{\cdot}25 \times 0{\cdot}15 \times 0{\cdot}15} \; \epsilon^{\frac{0{\cdot}0019 \times 3{,}467}{\sqrt{3}}}$$
$$= 48{\cdot}96 \times 1{\cdot}462 = 71{\cdot}65 \text{ amperes.}$$

If the smaller absorption term 0·0015 had been used the value of the exponential would have been 1·3499 and corresponding I_s 66·10 amperes. The value of I_s taken in the design of the station will be the higher figure 71·65 amperes.

4.—*Choice of Spark Train Frequency and Power of Station.*—The next stage is to settle the power to be employed in the transmitting aerial, and this depends on the capacity of the aerial, as the following will show.

It is necessary to assume some spark train frequency N and some working value for the logarithmic decrement δ.

For general working, a spark train frequency of 600 gives a good clear musical note which is easy to receive aurally ; and this value will be assumed in the design. The alternator frequency will, therefore, be 300 per second.

The value of the logarithmic decrement δ must be assumed here ; and in general it is taken from previous experience with similar stations where it has been measured.

For simplicity take $\delta = 0{\cdot}05$.

Three parallel examples will now make clear the method of deciding on a given aerial capacity ; and the corresponding aerial power will be deduced.

It will be noticed that the greater the capacity of the aerial the less is the maximum voltage ; and the less the power required in transmitting.

Take wave-length $\lambda = 3{,}000$ metres.

$\therefore$ Frequency $n = \frac{3 \times 10^8}{3{,}000} = 100{,}000$. $\sim$.

and $p = 2\pi n = 628{,}320$.

$K_2 = 0{\cdot}0075$ mfd.	$K_2 = 0{\cdot}005$ mfd.	$K_2 = 0{\cdot}003$ mfd.
$V_{2\,\text{R.M.S}} = \frac{I_{\text{R.M.S}}}{K_2 \cdot p}$		
$= \frac{70}{0{\cdot}0075 \times 10^{-6} \times 628{,}320}$	$= \frac{70}{0{\cdot}005 \times 10^{-6} \times 628{,}320}$	$= \frac{70}{0{\cdot}003 \times 10^{-6} \times 628{,}320}$
$= 14{,}855$ volts.	$= 22{,}280$ volts.	$= 37{,}140$ volts.
$V_{2\,\text{max.}} = V_{2\,\text{R.M.S.}} \sqrt{\frac{8n\delta}{N}}$		
$= V_{2\,\text{R.M.S.}} \times 8{\cdot}161$		
$= 121{,}250$ volts.	$= 181{,}800$ volts.	$= 303{,}200$ volts.

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Energy per spark: $=\frac{1}{2}K_2V_{2\,max.}^2$ =52·25 Joules.	=82·71 Joules.	=138·0 Joules.
Kilowatts for 600 sparks per second: =31·35 K.W.	49·63 K.W.	82·80 K.W.

It is now obvious that certain capacities are quite inadmissible from the point of view of permissible maximum voltage.

On the other hand, as the maximum voltage and power required diminish as the capacity goes up, a balance must be struck between an expensive aerial (large capacity) and small power plant, or a smaller and cheaper aerial and larger power plant. Local circumstances govern the choice in any actual scheme; but in no case does cheap power lead to very small aerials with correspondingly high power, because of the troubles with the insulation of the extra high voltages involved.

In this example the aerial will be designed to have a capacity of about 0·005 mfd., with a maximum voltage of 181,800 volts and aerial power of 49 to 50 K.W

5. *Design of Aerial to Give the Required Capacity.*—The quickest way to determine size and form of aerial is to use the curves or tables given by Professsor G. W. D Howe, D.Sc., in an article on "The Capacity of Radio-Telegraphic Antennæ," appearing in THE WIRELESS WORLD for December, 1914, and following numbers.

Referring to this article it will be noticed that:

r = radius of aerial conductor, in cms.;
d = distance apart of adjacent spans, in cms.
D = overall width of complete aerial span in metres;
l = length of aerial span, in metres.

Taking spread of twelve wires No. 10 S.W.G., where r is 0·1625 cms., then for the convenience of using tabulated figures without interpolation take $\frac{r}{d}=900$, whence $d=146{\cdot}2$ cms. and $D=11\times1{\cdot}462=16{\cdot}1$ metres.

Take now $\frac{l}{d}=300$, whence $l=439$ metres.

Table II. in the above-mentioned article now gives, in double-entry form, the capacity per foot run of the span (for $\frac{l}{d}=300$ and $\frac{r}{d}=900$) as 3·51 micro-microfarads.

Converting the span into feet and evaluating the capacity on the above basis

$$K_2=3{\cdot}51\times439\times3\times\frac{39{\cdot}4}{36}=4{,}540 \text{ m.mfd.}$$
$$=0{\cdot}00454 \text{ mfds.}$$

This is the theoretical capacity of the above aerial in space and takes no account of the proximity of the earth nor of the capacity of the leading-in fan.

(To be continued.)

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Digest of Wireless Literature

High versus Low Antennæ.

The present practice is to count the extended capacity of an antenna or at least a large part of it, at a great elevation above the earth. The author subjects this practice to a critical examination. The electric and magnetic forces set up at a great distance from an extended horizontal network of wires are discussed. It is shown that if the radius of an antenna consisting of a horizontal network of wires is two or three times as great as the height of the network above the ground, the electric and magnetic forces at a great distance from such a radiator are practically independent of the height of the network above the ground, provided the frequency of oscillation and the operating voltage from the network to ground are kept the same for the different mounting heights. That is to say, an extended network of wires charged to a given voltage and allowed to discharge to earth through an inductance tuned to give a frequency of say 100,000 cycles per second sets up the same electric and magnetic forces at distant points whether mounted 10 ft. or 200 ft. above the ground. In these two cases the rate of radiation (in kilowatts) from the two antennæ is the same, but the initial store of energy in the case of the 10 ft. mounting height is about 15 times as great as in the case of the 200 ft. mounting height. Therefore, the oscillation in the former case is much more persistent than in the latter; in fact, the oscillation becomes so persistent for low mounting heights that the power condensers and coupled circuits at present required in spark systems of wireless telegraphy may be dispensed with and a simple series circuit comprising capacity area, tuning inductance and spark gap may be used. Such a circuit has the merit of oscillating at a single frequency, whereas the coupled circuits have two frequencies of oscillation. Passing then to a comparison of the receiving properties of two stations with networks at different elevations, the author shows that if the radius of the network is large as compared with any feasible mounting height, then both stations are ultimately able to abstract energy at the same rate from passing electromagnetic waves, provided these waves are persistent and not rapidly damped.

The advantages of low over high antennæ for high-power stations are as follows:– Lower first cost (except where the cost of land per acre is very high); no necessity of power condensers; single frequency of oscillation; apparent possibility to obtain a smaller decrement than where power condensers are necessary; less likelihood of damage by lightning; probably less interference from "atmospheric." On the other hand, high antennæ have the following advantages over low antennæ; small antenna current (which may be of considerable advantage where arc generators or high-frequency alternators are used); a smaller number of insulators; less likelihood of interruption due to insulator failures. Edward Bennett, Bulletin Univ. of Wisconsin, No. 810 (Engin Series, Vol. 8, No. 4).

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Continuous Waves with a Spark Transmitter.

The drawing shows a transmitter described in U.S. Patent 1,166,892, issued in 1916 to R. A. Fessenden. The high-voltage direct current dynamo A charges the outer plates of the condenser B, through the resistance or impedance C. The condenser discharges through the oscillatory circuit formed by the adjustable

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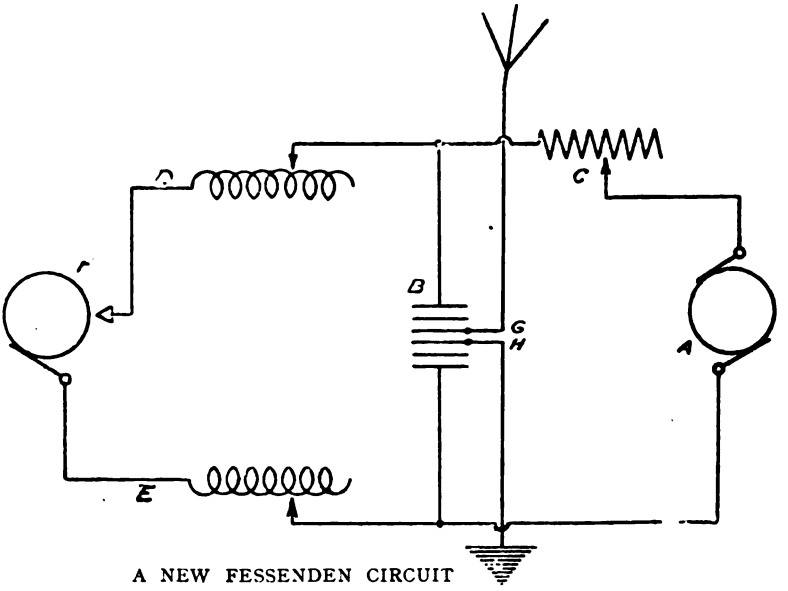
inductances in wires D and E, and the rotating spark-gap F. This gap consists of a stationary electrode placed near to a disc which revolves at high speeds; the inventor suggests that the relative movement of the two sparking points may be as high as 12 miles a minute. The construction may involve two rotating discs, or some other mechanical form which will operate at very great speeds and so prevent the formation of any arc in the gap. In such an arrangement, the specification states, continuous and regular discharges are produced and sustained, or practically sustained waves are generated at high efficiency.

The mode of coupling to the aerial circuit through the internal plates G H of the sending condenser possesses some interest. This is equivalent in many ways to the static-coupled transmitters which have recently been tried in connection



A NEW FESSENDEN CIRCUIT

with various types of arc and spark generators. In order to secure good transfer of oscillating current energy from closed to open circuit it is necessary that the radiating circuit be in tune with the local circuit formed by the plates of B, and the inductance in the lead wires D E. This is accomplished by the usual insertion of variable inductance or capacity in the antenna circuit.—*Popular Science Monthly.*

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ALKALI ACCUMULATORS.

A writer in a recent issue of our Contemporary "The Model Engineer and Electrician," gives some interesting particulars of the design of the Edison Accumulators. Against the high cost of these cells, says the writer, several advantages may be set, the most important being that they will stand very rough usage. If, for instance, alkali accumulators are allowed to stand in a discharged condition no injury results. Moreover, the cells may be charged and discharged at very high rates, and may even be short-circuited without any damage being done to the plates. Even if the current is passed into the cells in the wrong condition the plates will not suffer permanent injury. The plates will also stand any amount of vibration and

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jolting, this being one of the reasons why these cells have been used so extensively for working electrical vehicles. Lead accumulators, however, offer three main advantages over alkali accumulators. First, the initial cost is much lower, secondly, the voltage per cell is higher, and thirdly the efficiency is higher. The efficiency of a lead accumulator is about 75 per cent., whereas that of an alkali accumulator does not exceed 60 per cent. The electromotive force of an alkali cell is only 1.2 volts against about 2 volts for a lead cell.

The positive plates are composed of perforated steel tubes, heavily nickel plated and filled with alternate layers of nickel hydroxide and pure metallic nickel in excessively thin flakes. After being filled with the active material each tube is reinforced with eight steel bands, which prevent the tube expanding away from and breaking contact with the contents. The tubes are mounted in a steel frame or grid, which is also nickel plated. The negative plates are also composed of nickel-plated steel frames or grids, but in this case the pockets are rectangular and they are filled with powdered iron oxide. After the pockets have been mounted in the grids they are subjected to great pressure between dies, which corrugate the surfaces of the pockets and force them into practically integral contact with the grid. The plates are separated from one another by narrow strips of hard rubber. At the edges of the plates grooved rubber insulators are provided, which perform the dual function of separating the plates and insulating them from the sides of the container. Hard rubber is also placed between the surfaces of the outside negative plates and the container, whilst at the bottom of each cell a hard rubber rack is placed which insulates the lower edges of the plates from the bottom of the container. This bridge, however, is very shallow, since in an Edison cell no active material can leave the plates and accumulators at the bottom of the cell. The container is nickel plated inside and out, the object of this being to protect the case from rust. The terminal posts for the positive and negative plates pass through stuffing boxes fixed to the top cover, and between these stuffing boxes is an opening for filling the cell with electrolyte and for adding distilled water to make up for that which has evaporated during the charge. This opening is fitted with a water and air-tight cover and it is held in place by a strong latch.

The electrolyte consists of a twenty-one per cent. solution of potash, with a small quantity of lithia. In making the solution distilled water must be used and not tap water. Since the density of the electrolyte does not change hydrometer readings are unnecessary. The maintenance of these cells, in fact, is almost entirely a mechanical proposition, for all the attendant has to do is to keep the plates covered with solution by adding pure distilled water when needed, and to keep the steel containers dry and clean. The amount of water used depends entirely upon the service and the care that is taken when charging. If the cells are continually overcharged, there will of course be excessive evaporation of the electrolyte, and fresh water will have to be frequently added. Moreover, excessive overcharging involves waste of current and, in turn, waste of money. Alkali cells do not require long overcharges, for the plates cannot sulphate. After about two hundred and fifty discharges, the solution must be renewed, since it then shows a loss in strength, which, in turn, gives rise to a loss in the capacity of the battery of about five per cent. The renewal of the electrolyte not only restores the lost five per cent., but usually raises the capacity several per cent. above the original value.

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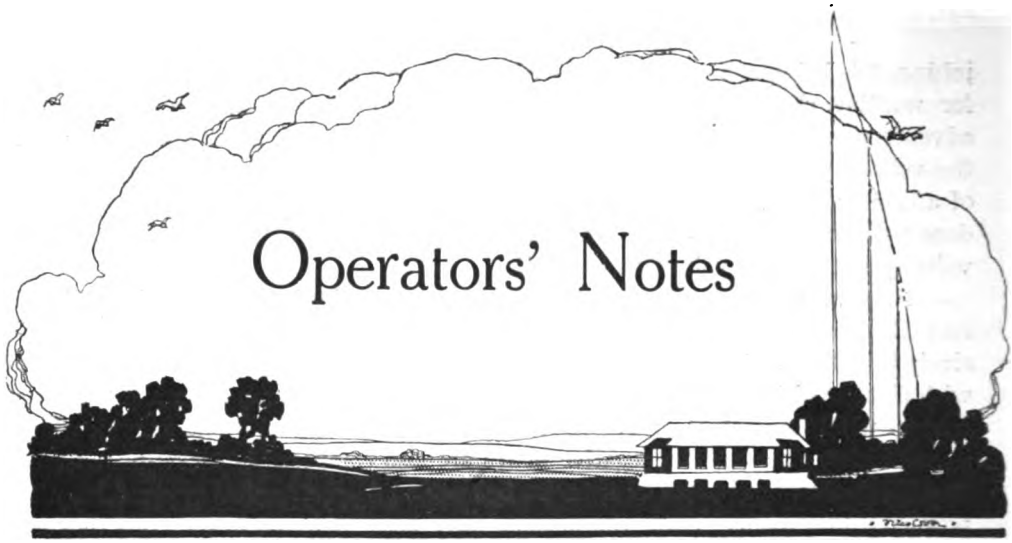

Some Notes on the Maintenance of Accumulators (III.)

By WILLIAM PLATT.

New Batteries.

It is a present-day practice when supplying new accumulator batteries to ship wireless stations to send the cells forward in a fully-charged condition, each cell containing its full quantity of electrolyte. Batteries received in this manner should be examined immediately on delivery, as despite many precautions, such as specially constructed travelling crates and lavish labelling, it frequently happens that a quantity of acid is lost during transit between the manufacturers and destination. With each battery there is supplied a porcelain bottle containing a gallon of dilute acid. Should it be found that acid has been lost from the cells during transit the necessary amount should be added to each cell, so as to bring the electrolyte from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. above the tops of the plates. The voltage and the specific gravity of each cell should be taken and the cells put on charge at the normal rate for a period of half an hour to an hour, as may be necessary, until all the cells are gassing freely.

When the cells are sent forward in a dry state the " setting up " of the battery needs more careful attention. The plates should be lifted out of each container, the packing removed, and separators fitted between each pair of plates. Care should be taken that the plates are placed on nothing likely to short the groups. It is better to lay the plates on one side so that the outer negative plate only comes in contact with anything else. The containers should be examined to see that they are perfectly clean ; the side insulating pieces and wooden bridge should be fitted into the containers and the two groups of plates carefully replaced in position, special notice being taken that the side insulating pieces are not crushed down underneath the plates. Acid of the correct specific gravity should then be added to each cell and the battery immediately placed on charge. This initial charge should be given at a rate slightly below the normal rate and continued from eight to ten hours after the voltage and specific gravity have ceased to rise.

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It is then desirable to discharge the battery to a half of its capacity, after which it should be re-charged until the voltage is 2.5 to 2.7 per cell on charge and all cells gas freely. This operation should be repeated from three to four times. During this period there will be considerable evaporation, to compensate for which water should be added to the cells after they are fully charged.

Indications that the cells are fully charged are as follows: (1) Specific gravity at maximum density; (2) voltage at maximum; (3) cells gassing freely; (4) electrolyte assumes a milky appearance; (5) positive plate becomes a chocolate brown colour; and (6) the negative plate becomes a light grey.

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BUCKLING.

During charging there is an increase of bulk in the positive plates produced by the reducing of lead sulphate ($PbSO_4$) to lead peroxide (PbO_2). If from any cause this expansion is not even over the whole surface of the plates the unequal expansion distorts the grids or frames and buckling eventually ensues. One prolific cause of unequal expansion is too rapidly discharging and the discharge being allowed to continue after the voltage has fallen below 1.8 per cell. Sulphating is a healthy action of a good cell. This action is going on during the whole time of discharge, but when the discharge is allowed to go past the limit referred to above the formation of insoluble sulphate (Pb_2SO_3) takes place and shows in white uneven patches over the surface of the plates. During charging the parts of the plate covered with insoluble sulphate do not expand equally with the other parts, and distortion of the grids takes place and buckling inevitably results. Another cause of insoluble sulphate is the acid being above strength, due to topping the cells with acid instead of water.

In such cases sulphating is carried on to excess. Acid does not evaporate, and the losses are very small indeed, therefore acid should not be added to the cells unless some of the electrolyte has actually been spilt.

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CARE OF CELLS.

Emergency batteries on shipboard will require to receive the greatest attention during the time a vessel is in port. It is important that when a vessel leaves port the cells should be in a fully-charged condition, and the battery should not be discharged during the time the vessel is at sea. On the voyage readings of the voltage should be taken and recorded daily, and if it should be necessary to give the cells a small charge this should be done on the low rate. On arrival in port the cells should be taken out of the accumulator cupboard and all leads removed from the containers. Connectors and wing nuts should be cleaned, readings of the voltage and specific gravity should be taken and the cells connected up outside the cupboard and put on discharge at the normal rate.

When the voltage of the twelve cells has fallen to 21.6 on load, a discharge should be discontinued and the battery immediately put on charge again at the normal rate, this charge to be continued until each cell is gassing freely. During the periods of charge and discharge the battery should never be left and frequent examination of the specific gravity and voltage should be made, all readings being

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correctly recorded. These records should be preserved, as they are one of the most helpful means of determining the condition of the cells. If during charging it should be noticed that one cell is charging slowly it should be taken out of the battery and carefully examined for short circuiting, later being replaced in the battery. When the battery is again discharged this cell should be left out of the circuit and only connected up with the battery when it is put on charge later. One of the causes of short-circuiting is pieces of paste from the plates breaking away and falling between the two plates. However, with the ship type cell the separators are packed between the plates very closely and such faults seldom happen. Overcharging after the cells are gassing freely is not recommended, and the only time when it should be necessary is after the cells have been left out of use for an extended period and allowed to sulphate in excess. When overcharging is necessary the rate should be decreased to a quarter of the normal rate. Slight sulphate may be removed by persistently overcharging at a low rate, say, two or three amps., and discharging at a special low rate, say, one amp. When the cells are fully charged the tops of the lead-lined containers should be wiped with a clean cotton cloth to remove any splashes of acid which have occurred during gassing. This prevents the formation on the lead lining of hard sulphate, which if allowed to collect eventually eats its way through the container.

Care should be taken to see that the water used for replenishing the cells is clean and pure. Distilled water is, of course, the best for this purpose, but is not always possible to obtain. On shipboard evaporated water is readily procurable, and this should be used when necessary. It is spoken of as "condensed water," but care should be taken not to confuse this with the water which has passed through the condenser tubes to the ship's boilers. This latter would be very damaging to the accumulators, as it contains all sorts of impurities. All terminals and connections should be kept scrupulously clean and treated with a thin coating of vaseline. The rubber sleeves on pole pieces should be always kept in position. These rubbers are really intended as insulators to prevent the cells discharging across the lids, a not unlikely occurrence in moist atmospheres or where dirt has been allowed to collect on the leads. It is an excellent practice to wipe over the whole of the outside of the wood containers frequently for the purpose of removing all conducting dust or dirt, as through such a medium it is possible for the cells to "ground."

It is important that all batteries shall be securely battened when placed in position, otherwise during the heavy weather the battery is likely to be thrown out of the cupboard. The inside of the cupboard should also be painted with anti-sulphuric paint, and in all cases the bottom of the cupboard should be provided with a wooden grid to raise the cells from the deck. In later practice it is usual to fit a lead-lined tray underneath this grid; this tray protects the deck from any acid that may be spilt.

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The Principles of Electric Wave Telegraphy and Telephony*

By J. A. FLEMING. Reviewed by Professor E. W. MARCHANT, D.Sc., of Liverpool University.

It is now just over ten years since Professor Fleming first produced this book. When it was issued it assumed at once a commanding position as an authoritative exposition of the scientific principles involved in wireless telegraphy. Since that time many books have been produced dealing with the subject, some from the point of view of the practical engineer engaged on the erection of stations, others from the point of view of the operator who has to handle the apparatus in an ordinary ship or shore station, but there is none that approaches Professor Fleming's in the completeness of its treatment of the subject from its scientific aspect, and which, at the same time, contains so much information which is of value to those who have to deal with the practical business of transmitting and receiving wireless radiograms.

The opening chapter deals with the production of high-frequency currents ; it is interesting to compare this chapter with the corresponding one in the ten years old first edition and to realise what progress has been made. Since those days the Alexandersen machine and the Goldschmidt alternator have been developed, and it is now possible to build alternators capable of developing 100 kilowatts or more of high-frequency power for radio-telegraphic purposes.

The Poulsen arc, too, has become a practical and effective machine for producing continuous electrical oscillations. All these are described in detail, and the mechanism of their operation fully explained.

A very elaborate account is given, also, of the production of damped electrical oscillations, and a number of photographs of electrical discharges is included. This chapter contains a small treatise on the induction coil and its use for the production of electrical oscillations, the various forms of break used in wireless work are described and the theory of their action discussed. The Pliotron oscillator which seems likely to prove a very important method of generating continuous oscillation is described later in the chapter on Radio-telephony.

The next chapter, on High-Frequency Measurements, is of the greatest interest to all radio engineers. It covers a very wide field, from the calculation and experimental measurement of capacity and inductance to the determination of dielectric hysteresis loss and the dielectric strength of air. The figures given for the variation in the specific inductive capacity of glass are of great interest ; they emphasise the irregular nature of the changes in dielectric capacity with frequency found by different observers. It is satisfactory to find that Professor Fleming's observations agree with those of most other experimenters in showing that the dielectric constant of glass with high frequencies is less than that measured ballistically. There is also a very complete account of the observations that have been made on the dielectric strength of air between spheres, which will be of value to many who are not radio engineers. The chapter on Damping and Resonance also covers a wide field. This

* *The Principles of Electric Wave Telegraphy and Telephony.* By J. A. Fleming. London : Longmans, Green & Co. Third Edition, 1916. 911 pages. Price, 30s. net.

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subject has been developed very extensively during the last few years ; a fact which is emphasised by the increase in size of the chapter compared with that in the earlier edition, but still more by the nature of its contents. The measurement of the decrement of an oscillating circuit is now almost as important as a determination of its natural wave-length and frequency. Professor Fleming lays emphasis on the effect of spark resistance on decrement in circuits producing electrical oscillations by the spark method. It is, however, unfortunate that no attempt has been made to compare the values of spark resistance measured by different observers on the basis of the instantaneous value of the current passing. An attempt was made by the author of this review in this direction in some experiments made many years ago and the results were fairly consistent. If a curve could be calculated showing the effective resistance of a spark between one-inch spheres when carrying different currents, the results would be of great value in the calculation of decrements. The figures given, while useful for capacities of the values used in the experiments, are generally of little service, since the capacities used are very rarely the same as those with which the experiments have been made. As the author observes, a full examination of all the factors affecting spark resistance has not yet been made, and the subject is one which might well engage the attention of scientific workers engaged on high-frequency measurements. There is a good theoretical treatment of the effect of coupling on resonance and on methods of measuring logarithmic decrements ; but the bulk of the latter subject is deferred to a later stage.

Part 2 of the book deals with Electric Waves. Chapter 4 is very much the same as in previous editions and deals with the production of stationary waves on wires. The next chapter now headed " Electric Radiation " is similar to the one on " Electromagnetic Waves " in the earlier edition. Some useful figures, due to Austin, are given of the effect of varying the emitted wave length on the apparent resistance of an antenna due to the induction of eddy currents in the surrounding earth. It would have been useful if the conductivity of the soil had been stated, so that a comparison could have been made with antennæ working under different conditions. A great deal of research work is published which is of little practical use, except for elucidating the phenomena described in the original research. It is a laborious task to sift out useful facts and figures from a multitude of papers and so provide reliable information based on the observations of a number of different workers ; though the task is laborious, it is worth doing, as there is usually little value in a series of detached scientific experiments. It would have made this book of even greater value if the data given could have been still further sifted and analysed. Chapter 6 deals with the appliances used for the detection and measurement of electric waves ; starting historically, it describes the development of the coherer and the magnetic detector.

A very complete bibliography is given of the work done on the effect of high-frequency currents on the hysteresis loss in iron. The electrolytic detector, the barretter, or hot wire detector, and the well-known rectifying detectors (such as the crystal and the Fleming valve) are dealt with fully. A great deal of valuable information is given about the latter device which, in its modified form as the audion and the Lieben Reisz telephone relay, seems destined to produce great results in the development of " small current " electrical engineering. Various forms of cymo-

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meters or wave meters are described, and the chapter ends with a description of the decremeter now largely used in all wireless measurements.

Part 3 deals with Electric Wave or Radio-telegraphy; that is, primarily, with the application of the principles laid down in the preceding chapters, but also with the practical problems that arise in the transmission of wireless signals. Although at the opening of chapter 7 the suggestion is made that those interested in the history of the development of Radio-telegraphy should consult other sources, a short summary is given of the chief steps in its development; the space occupied by this, however, is much less than in the earlier editions. There is an excellent description of the directive antennæ used in wireless work, though the experiments of Kiebitz on this subject are left to a later chapter. An account follows of the various methods of exciting an antenna, of the effect of tight and loose coupling and of the forms of spark gap or discharger now in practical use.

The chapter concludes with a description of the receiving apparatus used in connection with the various so-called "systems of wireless telegraphy," but also includes the Einthoven galvanometer and the Brown magnifying relay. The chapter on Radio-telegraph Stations will be of great interest to all radio engineers, as it contains a very complete description of the high-power long distance stations at Clifden and Carnarvon now regularly used for Transatlantic transmission, as well as that at the Eiffel Tower and at Tuckerton, New Jersey, where a Goldschmidt alternator has been installed. An account is given of military sets, and of some of the newer forms of aircraft transmitters and receivers. Subjects like the prevention of interference and the efficiency of radio-telegraph stations are included here. The small station described on page 785 with an overall efficiency of just over 4 per cent. is a very good example of "how not to do it," though Professor Fleming seems to think 25 per cent. as high an efficiency as it is possible to attain for a station of this size. The few pages on the design of a radio-telegraph station will be of value to many radio engineers. The chapter on radio-telegraph transmission will be of interest to all; the function of the earth is fully discussed, and an interesting collection of data, obtained mainly by Austin and Hogan at the U.S. Experimental Stations have been included; an account is given of the well-known sunset effect and of the variations that have been observed from day to day in the strength of wireless signals received from a station emitting daily messages. This is a subject which requires much further study, but the increase in our knowledge of it during the past few years has not been inconsiderable. The book ends with a chapter on Radio-telephony, a subject which has not perhaps developed as rapidly as some people anticipated. Progress has been made, however, and it seems as if the "Pliotron" already referred to may possibly solve the most difficult part of the problem, *i.e.*, the production of an absolutely steady train of electrical oscillations. A microphone capable of dealing with large currents also has not proved an easy thing to make; progress, though slow, has been steady, and the day may not be far distant when wireless telephones become of general practical utility. As this review indicates, Professor Fleming's book is exhaustive and complete; the new edition (especially the almost entirely re-written Part 3) gives a large amount of valuable information, and all those engaged in wireless work who make any pretensions to a scientific understanding of their subject should possess it.

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Wireless Telegraphy In the War

Self-centred Obsession.

A large number of people have been commenting upon the recent action of Germany in notifying neutral nations that they must submit to untrammelled U-boat piracy, as though their actions were actuated simply by sheer impertinent disregard for the rights of other people to exist. As a matter of fact, however, it would appear to be doubtful whether the course so taken by them was *consciously* impertinent at all. The modern German is so obsessed by a sense of his own importance, that nothing appears to him to matter in comparison with the welfare of Germany and the Germans. Provided that anyone with whom he is dealing is prepared to accept to the full all the consequences which follow from the doctrine that *Deutschland* is really and indisputably *Ueber Alles*, he is quite willing to consent to "accommodate" them in his own condescending way. This attitude is aptly exemplified by the announcement issued to the world at large through the German long distance wireless station, that the "All Highest" was "prepared to oblige" neutral governments and shipowners by placing the Nauen station at their disposal for radiating wireless messages to any ships at sea, which might otherwise, through ignorance, violate the boundaries of the sacred "War Zones" which the Kaiser's Ministers have been recently ruling across the seas surrounding Great Britain and her Allies! What such an announcement as this meant is nothing less than a confession that the German administrators are so besotted with their own sense of self-importance, as not to perceive that, in sending out such an announcement, they are but piling insolence on insolence. Just as they, apparently, failed to realise that it was outrageously insulting to attempt to dictate to independent nations exactly where and how they might despatch their vessels, under penalty of instant death to all their subjects on board in the event of "disobedience," so do they fail to realise that to offer facilities for blind acquiescence in such instructions is not a mitigation of their offence but an addition to it.

As far as Nauen station is concerned, it has already attained an unenviable notoriety. From this centre have been radiated the larger number of "wireless lies" and other malversations of the truth with which neutral nations have been flooded

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ad nauseam since the British cut all German cables in the first few hours of warfare. Readers will find a fairly full description of this Hun radio station on pages 919 to 923 of the present issue.

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WIRELESS VERSUS SUBMARINES.

Up to the present, one of the chief obstacles to the arming of British merchantmen with artillery capable of dealing with submarine piracy has been the refusal of neutrals to receive within their ports and treat on the footing of traders vessels so armed. As a result of such non-armament, practically the only weapon of defence possessed by British and neutral merchant vessels against German submarines of the later type has been their power of summoning the aid of men-of-war through the medium of their aerials. The account which Mr. Alfred Noyes was recently allowed to publish in detail of the escape of the *Anglo-Californian* through this medium admirably illustrates the consequent situation. In the earlier days of the war the speed possessed by enemy submarines was so limited that vessels were frequently able to escape by reliance upon their own superiority in this respect. Now that superiority has ceased to exist. Apart altogether from the strained relation resulting from the recent development of German audacity in the interest of "the freedom of the seas," there would appear to be good reason to hope that neutrals will in future desist from putting obstacles in the way of the arming of British merchantmen for defensive purposes, irrespective of the position in which the guns may be located. But even in such an event, the importance to merchantmen, when attacked, of being able to radiate from their aerials appeals for assistance, will be little less than it is at present. The size and gun power attained by the more recently constructed German under-water craft is such as to raise them almost to the status of cruisers, so that it would require more powerful warlike apparatus than would normally be at the disposal of the ordinary tramp steamer for the combat to be developed on equal terms if a single merchantman were acting "on her own."

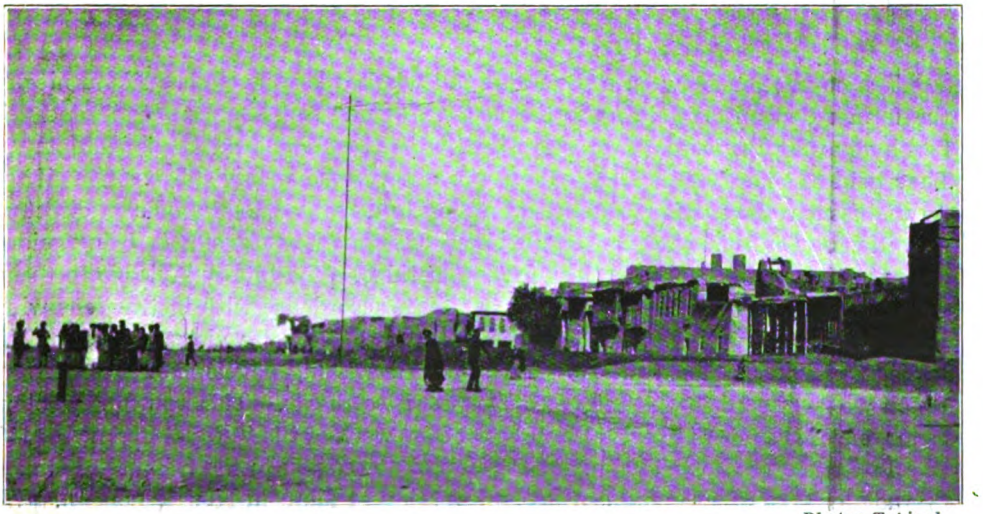

Photo: Topical.

BRITISH WIRELESS STATION AT KUT.

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[*Official Photograph per Central Press.*

WIRELESS DIRECTION OF ARTILLERY ON THE BALKAN FRONT.

THE ROYAL FLYING CORPS.

The co-relation between aeronautics and wireless is very close. The utility of the former depends largely upon the latter. In our last issue we illustrated this fact by quoting the words of an aeroplanist whose machine lacked radio equipment. They tend to show that it is of little use to observe the enemy's dispositions if the result of such observations cannot be promptly conveyed to the officers directing operations. On this page we show a group of gunners whose aim is being guided against a foe on the other side of a mountain ridge, a foe totally invisible to them, for whose benefit they are training their gun in accordance with instructions wirelessed to them from the air. The direction of artillery by aircraft through the medium of wireless constitutes one of the most striking developments in warfare which we have seen in the course of the present struggle. This gun-fire direction forms one of the most important branches of the work of the "Royal Flying Corps."

In former issues we have referred over and over again to the training of airmen in radiotelegraphy at many centres and notably at Marconi House, London. We have recently received an account of the activities of one of the branches of this

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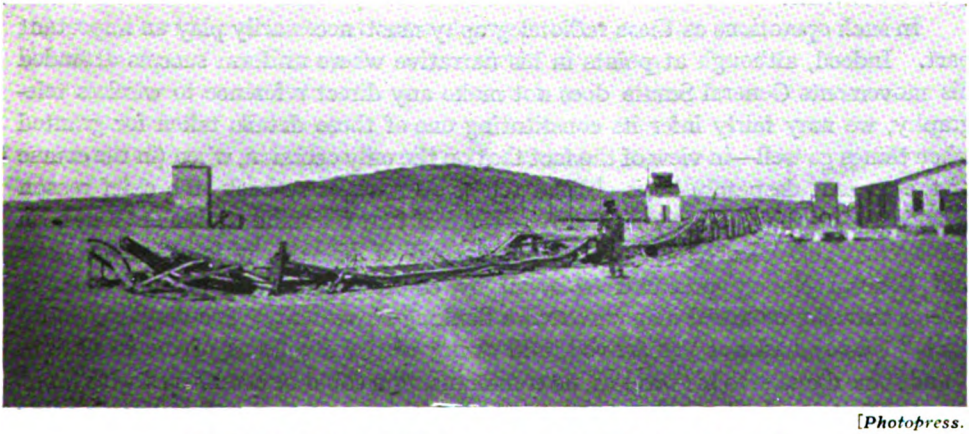
young but already world-famous corps. It comes from the East African Force, and was communicated by an aviator of Africander birth. The main point upon which he insists to start with is, that his own particular branch is constituted upon Royal Imperial lines: it is not the Royal African Flying Corps, but the South African Squadron of the Royal Flying Corps. "It reports direct to the Imperial Authorities, "and it also reports to South Africa. Apart from the actual flying, it is a self-"contained unit. . . . It guards its own camps, builds its own block houses to "protect its own aerodrome, and—when it wants to communicate with Head-"quarters—it speaks through the medium of its own wireless installation."

In our December issue we printed an account from one of the R.E. wireless men, and pointed out how absolutely essential it was that forces campaigning in such wild undeveloped areas should make the fullest possible use of wireless telegraphy. The communication with which we are now dealing confirms this opinion. Our correspondent enlarges upon the endless forests which lend themselves so admirably to the concealment of troops on foot, and where herds of game raising clouds of dust as they move along were frequently mistaken for troops on the march. On one occasion, it appears, a swarm of locusts was believed to be a dust cloud raised by the enemy. A Department, whose military organisation owed much to radio communications, "put on record the fact that the morale and actual effect of our "bomb raids were invaluable in destroying the morale of the enemy. . . . Men "who had previously spent the day in their dug-outs sheltering from the enemy's "artillery swarmed to the hill-sides to watch the smashing blows of the great "100 lb. bombs and hear the dull reverberation of the explosion whilst the enemy "camp became slowly enveloped in great clouds of dust and smoke."

The excellent arrangement under which General Smuts will attend the Imperial War Conference summoned by our present Prime Minister, which involves his relinquishment of the task which he has carried out so well, forms a plain indication of the fact that only the "cleaning up" process remains to be accomplished. But accounts such as those to which we have above referred, and that from which we



[*Photopress.*

WITH OUR FORCES IN EGYPT. A WIRELESS STATION WRECKED BY THE ENEMY BEFORE RETREATING.

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have just quoted, conspire together to indicate, as history alone will be able to recount in detail (when it comes to be written), the formidable nature of the task the East African Force undertook, and the difficulties with which commanders and commanded had to wrestle. Only detailed narration can do anything like justice to the importance of the part played in this work by radiotelegraphy, and by the gallant pilots and observers of the Royal Flying Corps.

* * * * * *

HUMAN INTEREST IN AN OFFICIAL DESPATCH.

Some particulars, of the kind referred to above, figure in the official despatch issued as a supplement to the *London Gazette* under date of the 17th January last, wherein Lieutenant-General Smuts reports his operations up to the end of October last. This report includes a summary of operations extending over a considerable time and covering a wide field, so that it is impossible here to attempt any epitome ; but we can assure readers that a perusal of the document itself, side by side with " the Large-scale Map," which the late Lord Salisbury so constantly recommended to newspaper readers, would amply repay them for any expenditure of time and attention.

The first impression given by perusal is that the key to General Smuts's practically invariable success lies in his decision to adopt the line of advance least expected by the enemy. This comes out over and over again in the course of his narrative. When dealing, for instance, with the occupation of the Pare, Usambara and Handeni areas, the General writes : " Our advance was expected to follow the railway, which " had been fortified at all convenient points for 100 miles. . . . I therefore decided " on the following dispositions for my advance." The " dispositions " of which he speaks consisted largely of utilising mountain tracks and passes, and even in places of cutting a path for his forces across virgin territory so as to materialise his search after the unexpected. The results attained justified General Smuts's judgment. The rapidity, with which the Anglo-Africander Forces advanced, " exceeded my " best expectations ; we had reached the Usambara in 10 days, covering a distance " of about 130 miles over trackless country along the Pangani River and through " the mountains."

In such operations as these radiotelegraphy must necessarily play an important part. Indeed, although at points in his narrative where uniform success attended his movements General Smuts does not make any direct reference to wireless telegraphy, we may fairly infer its constituting one of those details taken for granted when things go well—in view of the fact that on the only occasion, when (in the course of the present despatch) he is obliged to record a slight setback, the chief reason for this mishap is put down specifically to the fact that the radio equipment had been damaged. This occurred in the neighbourhood of Kissaki, which General Brits and General Nussey prepared to assail by co-ordinated attack, whilst General Enslin with the mounted men executed a flanking movement. The despatch states that " Nussey had not yet arrived, and owing to the roughness of the mountains " and some damage to his wireless, no communication could be established with him," General Brits made the attempt alone ; the position was found to be strongly held ; and the enemy were able to keep Enslin at bay ; eventually succeeding in outflanking him, with the consequence that the whole force was obliged to retire. Nussey,

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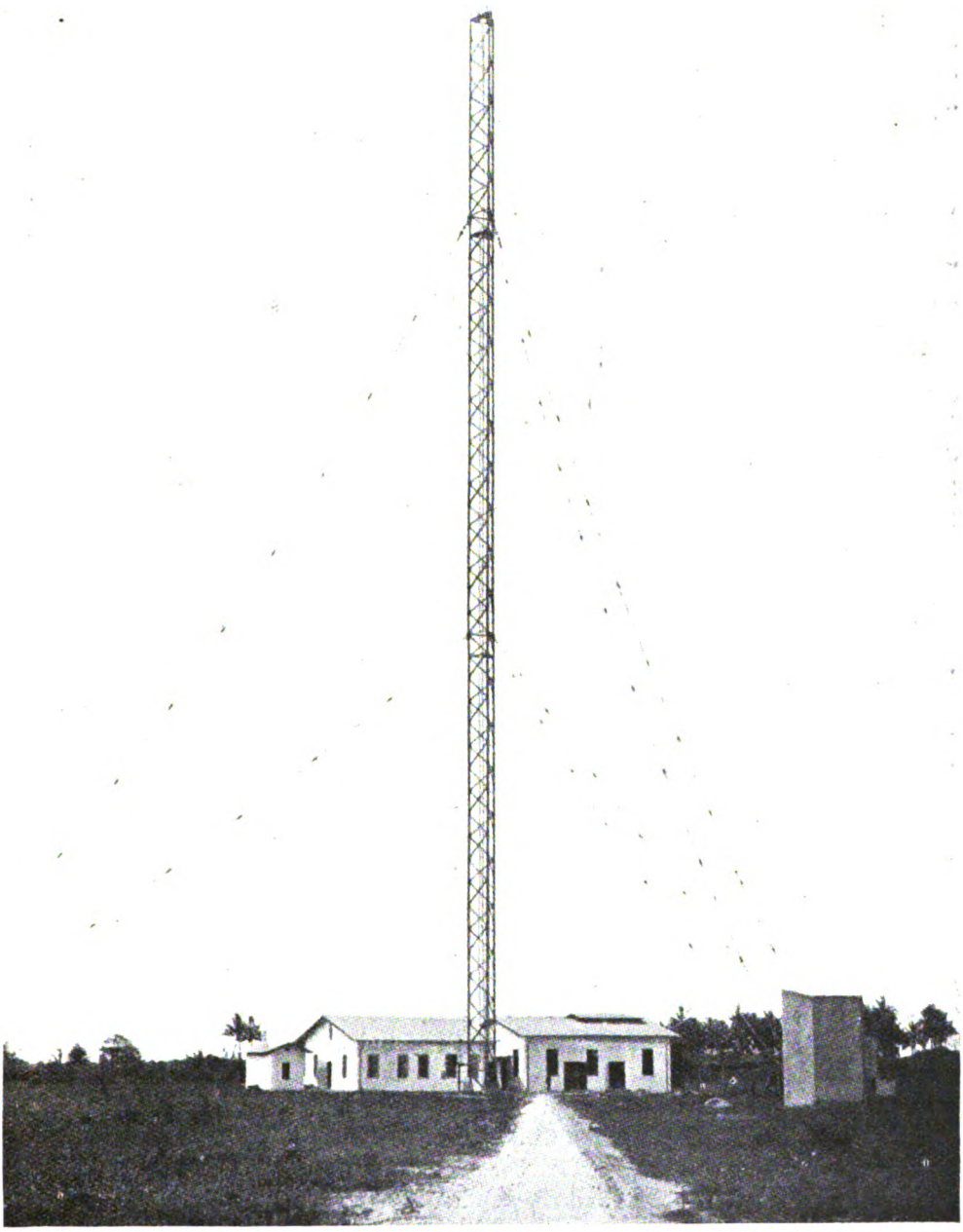

A PRIMARY OBJECTIVE IN GERMAN EAST AFRICA: the powerful Telefunken long-distance station at Dar-es-Salaam. It was bombarded by the Navy, and surrendered on September 3rd, 1916, the enemy forces having retired a few days before.

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in total ignorance of these events, as well as of the position of General Brits, arrived before Kissaki on the morning of the following day. Instead of attacking he found himself attacked; and was in his turn obliged to withdraw. General Smuts comments: "If communication between Brits and Nussey could have been maintained "there is no doubt a general attack would have led to the capture of Kissaki, whereas "the two isolated efforts led to a double retirement and a regrettable recovery of "enemy morale."

A further illustration of what may happen when, for some reason or other, wireless apparatus cannot be used will be found in the account of the earlier manœuvres of General Enslin's column before it debouched from the 'Nguru Hill-Ranges; for we read that "one of Enslin's mounted regiments had lost its way in the moun-"tains and had finally emerged at Matamondo," a point situated at a considerable distance from its intended objective.

The wireless installation of our German foe had originally been very complete, and formed an essential part of his military defences. The daily Press have reported the destruction of the great long-distance stations, like that of Dar-es-Salam which forms the subject of our illustration; but we learn for the first time from this despatch how, one after another, the radio stations at Kondoa Irangi and Mwanza (where the installation is criticised as "powerful"), as well as several smaller installations, were dynamited by the Germans, to prevent their falling into our hands.

The language employed by General Smuts throughout this official report is characterised by extreme restraint. It is therefore all the more interesting to note the unqualified praise with which he closes his despatch. He will not dwell upon the gallantry of his men because, "in view of the foregoing statement of the main "facts, eulogy of the troops appears unnecessary and misplaced. The plain tale of "their achievements appears the most convincing testimony to the spirit, deter-"mination, and prodigious efforts of all ranks. . . . Great credit is due to the "Signal Service (to which the wireless sections are attached) for the really excellent "way in which communication has been maintained. The resources of the Service "have been strained to its furthermost limits, and it has only been by unremitting "efforts that success has been achieved."

Insurance by Wireless

ACCORDING to the *Spectator*, U.S.A., the Prudential Insurance Company of America is probably the first company to employ the wireless telegraph to transmit insurance funds to a foreign country.

In August, 1896, in Amsterdam, N.Y., Gertrude E. Orth took out a twenty-year Prudential endowment policy for $1,000. Soon afterwards she moved to Germany. The policy matured this year and the Prudential was anxious to pay it. To send it by mail meant a war risk, however, so the policy proceeds were deposited with the National Bank of Commerce in New York city, with instructions to notify its correspondent at Frankfort-on-the-Main, Germany, by wireless that it had the money for Mrs. Orth. The notification was successful.

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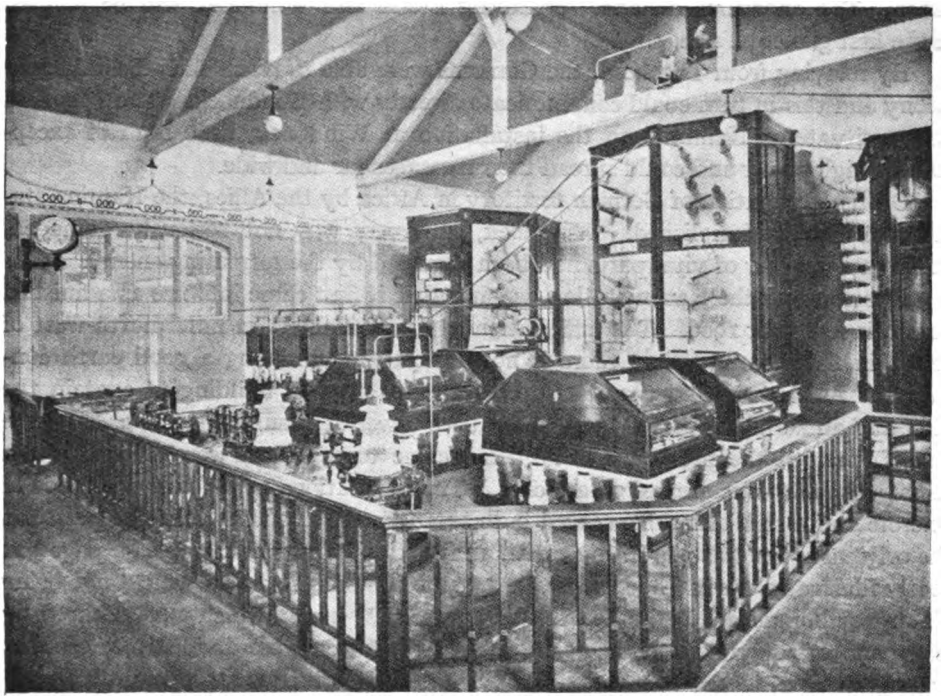

THE TRANSMITTING APPARATUS AT NAUEN.

Germany's Central Wireless Station

The Installation at Nauen.

AMONG the wireless stations which have come into prominence in the great war is that of Nauen, the giant Telefunken station in the vicinity of Berlin. Of extremely high power and with a central mast ranking as one of the tallest in Europe, Nauen, in conjunction with Eilvese (described in our October issue) had handled at the German end the bulk of the enormous transatlantic wireless traffic upon which the Central Empires have had to rely since the cutting of their cables on the eventful 4th of August, 1914.

Had Germany gained her world aspirations and retained her Colonies, Nauen would now be the centre of a giant long distance wireless scheme inter-linking the distant Colonies with the Fatherland. In the early part of 1914 and before even a small cloud of war had appeared on the horizon, a series of elaborate and careful tests had established the fact that Nauen could communicate with Togoland, the little German Colony on the west coast of Africa which was later to fall to the allied troops. Not only was direct communication from Germany to Togoland found possible, but it was also reported, and we have no reason to doubt the fact, that signals from the great station could be faintly heard when conditions were extremely favourable, as far south as Windhoek, the one-time capital of German South-West

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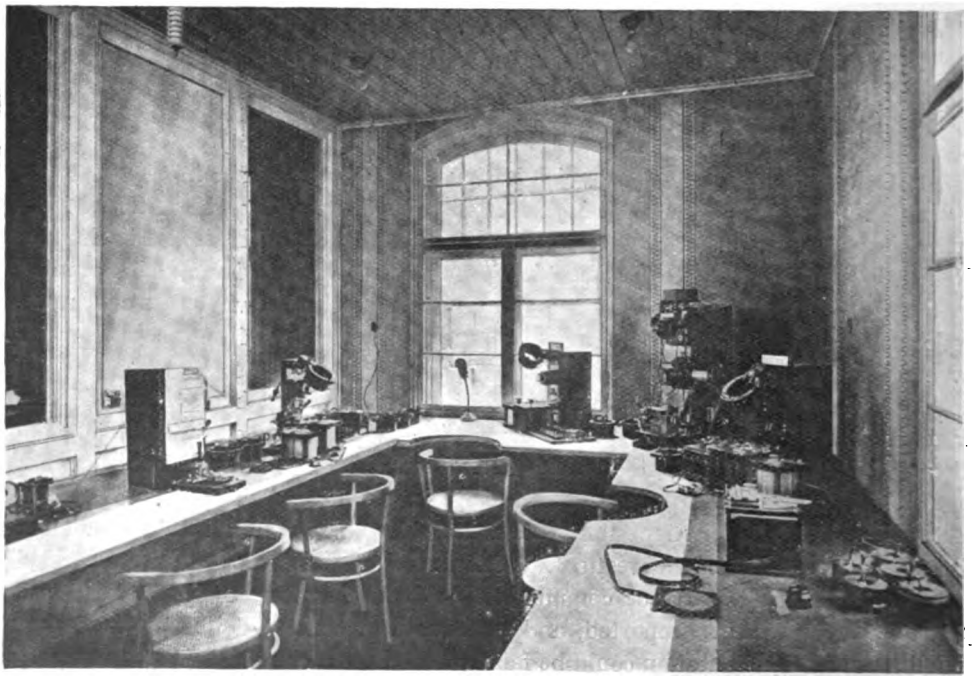
Africa. The enormous distance separating Berlin and Windhoek will be realised on the first glance at a map.

By relaying from Togoland, the Germans were able to reach their East African Colony and this in turn could communicate directly with Windhoek. The Togoland station situate at Kamina and the installation at Windhoek, were both of exceptionally high power and could spread their messages far and wide.

On the occupation of German territory in Africa by the Allies, the Kamina station was found demolished. Windhoek, however, was not seriously damaged, although a number of vital parts had been removed by the retreating enemy.

Returning to the Nauen station, we find that it first came into use as a finished station in the year 1906. The installation is situated about 12 miles north-west of Berlin, in flat country where there is no difficulty in obtaining a good earth connection. As first erected the station consisted of a small building to contain the plant and an aerial supported by a steel lattice tower of triangular sections. At the base of the mast the girders which formed it came together and were embedded in a cast steel sphere which rested on a socket. The foundation of the tower was made of concrete and a slab of marble served both as an insulator and to take the pressure. The original tower was 300 ft. high with 12 ft. sides. Our photograph on page 921 clearly illustrates the method of supporting the base of the tower which, not being self-supporting, needed to be carefully stayed. The stays, which were secured by heavy anchors about 600 ft. from the foot of the tower, were divided into sections by insulators, as it was found that without such sub-division strong surgings were set up, which detracted from the power radiated.



NAUEN. THE RECEIVING ROOM.

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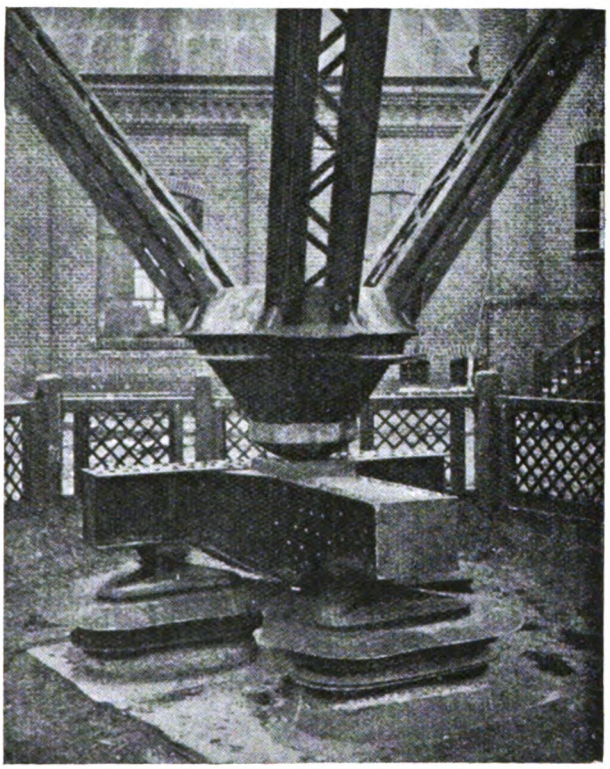
The aerial first erected was of the umbrella form, in six segments, arranged so that the opposite sides balanced one another. The whole aerial, which could be raised or lowered by means of pulleys, covered about 650,000 square ft. The "ribs" of this umbrella aerial were held outward by means of hemp cords connected to porcelain insulators. It should be noted that the aerial wires were not insulated from the mast, which thus formed a part of the oscillatory circuit. This practice is adopted in a number of Telefunken stations.

The earth wires, which were made of iron, radiated fanwise, 108 wires splitting into three at their extremities making 324 in all. The space occupied by the ground connection was over 30 acres.



BASE OF THE MAIN TOWER, NAUEN.

The first station building was a two-storey structure with the operating rooms, receiving apparatus and sleeping accommodation on the ground floor, and the condensers, spark gaps, and jiggers on the first floor. At first the power was about 10 kw., but three years later a 36 h.p. steam engine was installed and drove a 25 kw. 50 cycle alternator, which charged a large bank of glass tube condensers through four transformers. The condenser consisted of three sets of 120 jars, with a total capacity of 400 microfarads. The jigger, which was of direct-coupled type, consisted of a helix of silver-plated tubing. The spark gap was of multiple form (not the quenched gap, for this was not invented at the time) and was air cooled.

The operating and receiving room contained nothing of special note, the receivers being of the usual Telefunken type, and the change from transmitting to receiving being effected by a large antenna switch.

In 1911 the power was raised to 35 kw., and since that time has been increased on several occasions. There is good reason to believe that since the outbreak of war great changes have been made at Nauen. Transmitting apparatus for continuous waves as well as of spark type have been installed for some time. The continuous wave apparatus at the outbreak of war consisted of an inductor alternator generating 250 kw. at a frequency of 8,000 cycles per second, this frequency

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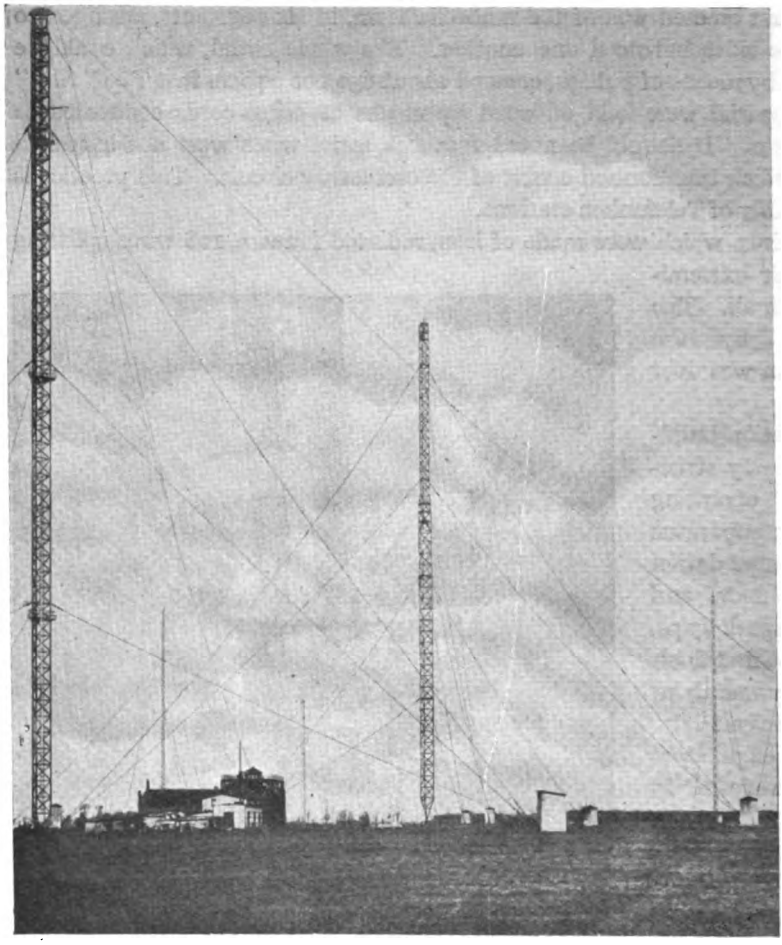

NAUEN. THE STATION BUILDINGS AND THE MASTS. THE 900 FOOT MAIN MAST IS SEEN IN THE CENTRE. IT IS SURROUNDED BY FIVE LESSER MASTS.

being increased a number of times by special frequency multiplying apparatus of the Joly type. No less than 100 kw. was said to be delivered to the aerial, the antenna current being 120 amperes.

The illustration at the head of our article clearly shows the quenched spark transmitter at Nauen. The two heavily insulated leads from the transformer beneath the floor will be seen just to the left of the centre of the photograph, and the condenser (now consisting of copper and glass plates immersed in oil and no longer of the tubular type) will be seen behind them in the corner of the room. The four glass cases on insulating feet contain the numerous banks of quenched gaps, which are cooled by a strong blast of air. The large case against the further wall contains the jiggers, the single pole switches being used for changing the internal connections. A large aerial ammeter will be seen on the extreme left of the photograph, just below the decorative dado of painted inductances and condensers. Readers should also note the festooned wave forms supported by insulators painted on the wall. The receiving room is shown on page 920 and contains accommodation for a number of operators. The tall piece of apparatus on the right hand side of the window (not in the window itself) is a microphonic amplifier, which at one time was used with success to increase the strength of the received signals. It has now been replaced by a form of three electrode-valve, which acts both as a detector and amplifier.

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Outside the buildings great changes have been made. First of all the 300 ft. mast was increased in height to 600 ft., but it had scarcely been completed when the whole structure crashed to the ground in a gale. Undeterred by this the engineers recommenced the work, and after many months of labour the new tower, nearly 1,000 ft. in height, was safely hauled into position A number of other towers were later erected, smaller than the central tower, but still very tall as masts go, and a new aerial of the double inverted-L type was erected. The new aerial, of course, required a much more extensive earth system than formerly, and many miles of wire are now embedded in the ground for conveying the high-frequency current to earth. The new central mast is of a similar construction to that first erected, and rests on a similar ball and socket. Our full page illustration gives some idea of the appearances of the masts and stays. The aerial wires, however, are too fine to be seen in such a photograph. In the distance can be seen the large station buildings and a good idea is obtained of the surrounding flat country.

Nevertheless, with this giant aerial and the high-power plant employed, Nauen has not been uniformly successful in its transatlantic work. On many occasions in bad conditions long-drawn out calls from POZ (Nauen) to WSL (Sayville) have vibrated through the ether without any answering call from the other side of the Atlantic. When conditions are favourable, however, and with the delicate amplifying receivers now in use, Nauen has been heard at very great distances, even on the west coast of America.

Among the Societies

The Wireless Institute of Victoria, Australia.

THE Wireless Institute of Victoria was inaugurated in the year 1913, and in the twelve months prior to the outbreak of war did much for the progress and enlightenment of its members, who totalled 110.

Thanks to the assistance of Mr. Balsillie, at that time Engineer of the Commonwealth Radiotelegraphic Service, a number of tuned installations were erected by the members. Mr. Balsillie also kept the Institute well posted with full particulars regarding call letters, etc., of land stations and ships in the Commonwealth. Many lectures were given by leading Victorian Scientists, including a brilliant and instructive demonstration of "Electrical Discharges in Air and Vacuum," by Professor Kernott, at the Melbourne University, and a lecture by Dr. Endacott dealing with Electric Wave Transmission as applied to X Ray Work. These were greatly appreciated.

On the outbreak of the war, amateur wireless working was of course immediately suspended and the majority of members, eager for further wireless experience, instantly offered their services in H.M. Forces for wireless work ashore and afloat. A number are also employed by Amalgamated Wireless (Australasia), Ld.

Credit is due to the Institute for the prompt way in which ninety per cent. of its members answered their country's call. At the present moment, these young men are in the fighting line and on the sea, carrying out those duties which have taken such a prominent place in the world-conflict.

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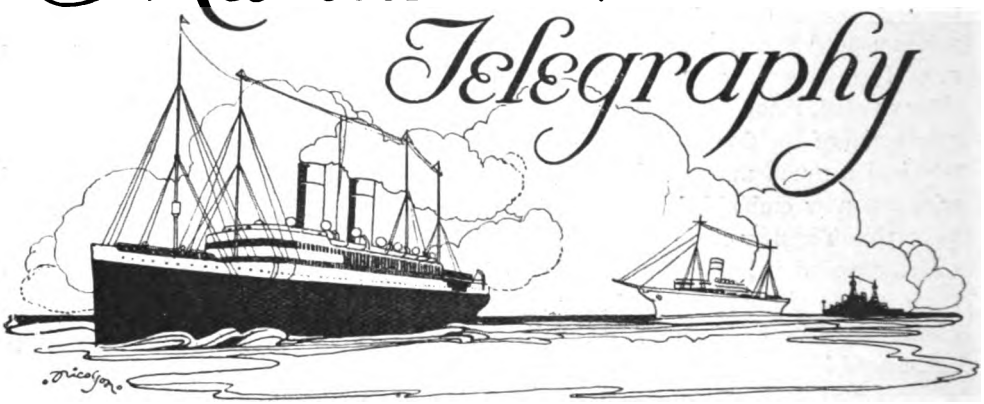
Maritime Wireless Telegraphy



British Traditions Upheld.

H.B.M. Auxiliary Cruiser *Laurentic* was sunk off the Irish Coast by a German mine or submarine late on January 25th last, and at the Coroner's inquest on seventy-four of the victims, Captain R. A. Norton, R.N., the Commanding Officer, bore proud testimony to the upholding of traditional pluck and coolness in the face of danger. She met with her fate at 5.55 p.m., an hour after leaving port. The Captain was on the bridge, when a violent explosion took place " abreast of the fore-mast on the " port side the ship ; followed, twenty seconds later, by a similar explosion abreast " of the engine-room on the port side." The *Laurentic* was at the time steaming full speed ahead and showing no lights. Captain Norton immediately ordered " full speed astern," fired a rocket, gave the order to turn out the boats, and issued instructions that a wireless call for help should be radiated. It was found, however, that no radio message could be sent, because (in the Captain's own words), " the " second explosion which occurred in the engine-room stopped the dynamos and " left the ship in darkness." Of course, in itself, this would not have prevented the wireless being worked, seeing that emergency sets are always carried on British steamers for the express purpose of taking the place of the regular source of power in cases where the latter gets cut off. We are, therefore, probably justified in inferring that the second explosion not only stopped the dynamo but also caused such damage in the wireless cabin as to prevent the auxiliary apparatus from being used.

The Captain himself set a noble example. Not only was he, to use his own expression, " naturally the last to leave," but whilst the ship was settling in the water he descended into the hold and the men's quarters between decks to search with his electric torch for any who might have been disabled and prevented from saving themselves. There was no trace of panic ; the boats were as coolly manned and handled as though those engaged in the operation were performing peace-time " boat drill," and the Secretary of the Admiralty was able to issue the following Official Statement :

" There was ample time to save everybody, the ship was carefully searched " above and below, and all hands were put into the boats. Those who were

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"lost perished owing to the cold and severity of the weather preventing them "from reaching the shore."

It is sad to record in the face of such heroism that out of her complement of 470 the survivors number only 121; so that 349 officers and men have perished.

The *Laurentic* was before the war the property of the White Star Line, and employed on the Canadian route. A triple-screw steamer of 14,892 gross tons, she was built by Harland and Wolff, of Belfast, in 1908.

* * * * * *

RECRUITS FOR THE NAVY.

THE naval recruiting authorities are anxious to make known the advantage they can offer to lads about to be called up for military service. Marconi operators are wanted and the age limits are 18 to 23. Those who have not yet received individual calling-up notices may, when they report for attestation, notify the recruiting officer of their desire to offer for this service, and if found suitable they will be given four months' training at the Crystal Palace, after which they will be posted to ships where there are vacancies. Service is for the duration of war, and those who join will be able to look forward to the after-war prospect of returning to civil life qualified to take up a profession that promises to be lucrative. There are other vacancies in the Navy that will enable youths of 18 to combine national service with the task of fitting themselves for paying professions after the war. Unfortunately, very little is known of these openings, but the naval recruiting officers attached to the various depots are now taking steps to supply information.

* * * * * *

SALVAGE INDEED.

In our January issue we recorded, as one of the adventures which seemed to crowd "thick and fast" around the Dutch steamer *Rijndam*, the fact that she answered a wireless SOS signal from the *Vigilant*, a little tug owned in New York, and bound from Newfoundland to Cardiff. The Dutch steamer proceeded to her assistance,

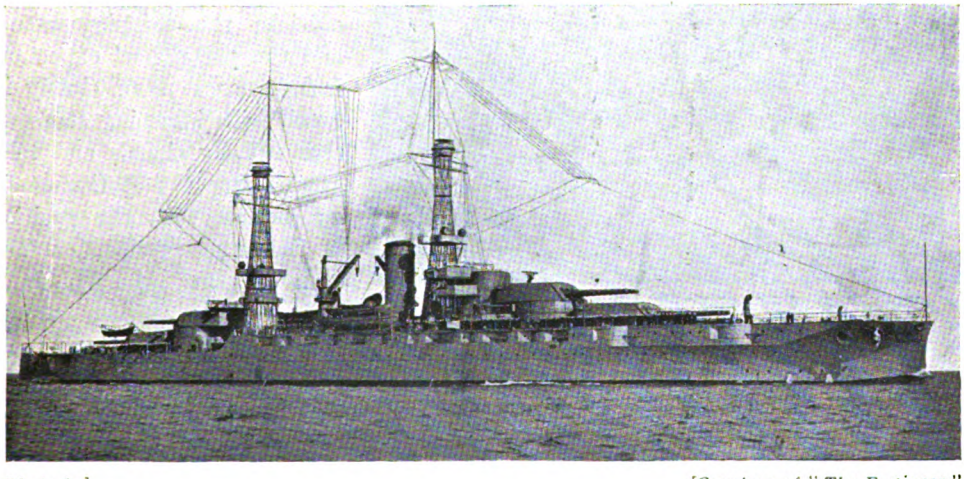

Photo by] [*Courtesy of "The Engineer."*

U.S. BATTLESHIP "ARIZONA." SEVERAL DISTINCT AERIALS ARE COMPRISED IN THIS ARRANGEMENT.

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and took off the Captain and twelve of the crew. Robert Ferguson, the second mate, however, offered, if a couple of others would volunteer to assist him, to finish the voyage and bring the vessel to her destination. Two firemen, named Thomas Welch and John Smith, volunteered, and despite the terrible weather encountered *en route*, which smashed several parts of their little craft and kept them for fifty hours on end without food, water, or sleep, they succeeded in reaching Berehaven.

Interest in the case was recently revived by the men being awarded salvage amounting to £5,000; one half of which went to Ferguson, whilst the other half was divided between the two firemen.

* * * * * *

NO NEWS.

In normal days of peace, which now seem so far away that we scarcely realise what they are like, relatives of ocean travellers when they go to the docks of a great port in order to meet friends arriving from perhaps the other side of the world, have their attention arrested by a number of notice boards, similar to those displayed upon the platform of many great railways. They can see chalked upon these boards the movements of the vessels expected to arrive, together with a note stating alongside which pier or jetty they will moor. This information is, for the most part, due to wireless telegraphy, which thus keeps the shore officials, the shipping agents and the passengers' expectant friends even more closely in touch with incoming steamers than railway signals and telegraphs keep the station staffs *au courant* with the position of incoming trains. The economy in time, patience and money which results therefrom is so large that it can scarcely be estimated.

NO NEWS FOR THE PORT OFFICIALS TO RECORD.

Our illustration, on this page, depicts one of these steamer notice boards and its attendant "Familiar" on the quays of Hoboken—the railway entry to New York Harbour. The man is there, his chalk is ready, yonder hangs the board, but the entries are blank; no wireless intelligence is hastily scribbled as heretofore upon the spaces destined for it. This is one of the results of war, a plain indication that "all who run may read"—or rather, perhaps, in this case "fail to read"!

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Notes of the Month

A Hardy Annual.

Our enterprising contemporary, *The Daily Express*, quoting recently from the *New York World*, speaks of a "wireless dog" as the "latest American invention." Many readers of The Wireless World will doubtless remember that in July, 1915, on page 214, we gave particulars of this ingenious mechanical animal, whose idea was suggested by Mr. John Hays Hammond, jun., whilst the mechanism was worked out by Mr. Meissner. The reference made in the *Express* paragraph to selenium cells located behind the eye-lenses and controlling a relay which actuates the motor and one of the two steering magnets at the rear of the device, plainly indicates that the animal in question is our old friend. To speak of it as "wireless," however, is a slight misnomer; in view of the fact that the controlling power is actuated by a beam of light and not by radio-telegraphic waves. There are certain "hardy annuals" which, like the great sea serpent, appear to turn up afresh at various intervals, and this "gay dog" would appear to be one of them.

* * * * * *

Prominent Recruits for the R.E. Wireless Section.

The Wireless Section of the Royal Engineers appears to possess special attractions for men of distinction who, under present war conditions, transfer their activities into military channels. Amongst the recruits who have recently attached themselves to this branch of H.M. fighting forces are Captain Priestley and Mr. Bickerton. The former accompanied both the Scott and Shackleton Expeditions as geologist and published a book dealing with his adventures. The latter was at one time connected with the Gaiety Theatre and enjoyed a close friendship with Mr. Charles Frohman. Mr. Bickerton used to keep up a luxurious flat in Paris and last year dispersed his valuable collection of Eastern curios in aid of the French Red Cross.

* * * * * *

Language in the Making.

Anyone who has the curiosity to compare the language used by newspaper writers of to-day and that employed by writers in the same newspapers 100, or even 50, years ago will notice considerable changes in the vocabulary employed. These developments of the English language are constantly going on; every new discovery adds its own quota, and the flexibility of our native tongue is indicated by the ease with which these are absorbed. In the *Daily News* of 1868 the word "cablegram" is referred to as "a new word . . . used by a New York contemporary to criticize a telegraphic despatch." Wireless telegraphy is responsible for quite a number of additions to the modern British vocabulary, amongst them being such words as

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" Marconigram," " radio-telegraphy," " Marconi system," etc. We have even seen the word " wireless " used as a verb, and as a matter of fact it would seem to fill a decided gap differentiating the act of radio transmission from the more general terms of " to wire," " to telegraph," or " to cable."

Wireless for Women

Mexican Girl receives Operating Licence.

ON several occasions we have made reference in our pages to wireless telegraphy as a profession for women, and in a recent issue we published a photograph of a number of young ladies who are now performing special duties at one of the great wireless stations in Wales. In this country no attempt has been made to place women as wireless operators on board ship, and it is unlikely that any change will be made in the present restriction of ship operating to men. In a few cases the Postmaster-General's Certificate has been obtained by lady students; the first case to our knowledge being that of the wife of a naval officer who obtained her " ticket " a year or so before the outbreak of war.

From the United States now comes the news that a Miss Maria Dolores Estrada has passed an examination for the highest class licence awarded by the Department of Commerce of the U.S.A., and is said to be the first lady to receive a First Grade Commercial Wireless Operator's Licence.

Miss Estrada has had an interesting career. She was born at Zacatecas, Mexico, on the 21st of July, 1890, and studied at the Normal School from which she graduated as a telegraphist when she was fifteen years old. For one year Miss Estrada worked at the Central Telegraph Office at Zacatecas, and was then transferred to Villa Garcia as Chief Telegraphist. Here she remained for another twelve months, after which she proceeded to Villanueva, where she remained for three years, occupying the same position as at Villa Garcia.

It was while Miss Estrada was at Villanueva that the first Mexican insurrection broke out. In this affair the leader, Madero, came into conflict with Diaz. As the young telegraphist had sympathies with the former she joined his staff, and, on Madero rising triumphant, she was appointed chief of the Mazapil Telegraph Office, one of the most important offices in the State of Zacatecas.

Miss Estrada continued working for Madero throughout the insurrection of Pascual Oroaco, when she had to work day and night without rest. Trouble in this revolutionary country still continued however, and when Madero was killed by Huerta, in 1913, a new insurrection broke out. The enterprising young lady sided with Carranza, and worked under the orders of General Gutierres until the troops of Huerta arrived at Mazapil. Huerta's troops, under Fomal Velaquezin, captured Miss Estrada and her mother, stole the telegraph and telephone apparatus and took the ladies to Concepcion del Oro (15 miles from Mazapil), where they were kept prisoners for twenty-two days. Then General Gutierres returned to the town with 2,000 men and, after taking the town and killing nearly 600 Federal soldiers, released

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the young lady and her mother. Later on, after further adventures, Miss Estrada set out to the capital of Nuevo Leon, but on reaching Saltillo, she met an old acquaintance of her Mazapil days, General Francisco Coss, who gave her a letter of introduction to Carranza. On presenting this letter to Carranza, Miss Estrada was ordered to join his staff as telegraphist in July, 1914. Here she worked until January, 1916, when she went to the United States and began the study of English at Fairmont Seminary. In May last she entered the National Radio School, and prosecuted her studies so successfully that she obtained the First Grade Commercial Wireless Operator's Licence in five months.

MISS MARIA DOLORES ESTRADA.

Of Miss Estrada's future plans we have no knowledge. Perhaps she will return to Mexico and take up important work in connection with the radiotelegraphic service of that country. In any case, for one who has seen so much and shown such great enterprise there should be a brilliant future.

The Marconi Companies and the War Loan

WE are pleased to be able to announce that the Directors of Marconi's Wireless Telegraph Co., Ltd., have offered to assist the staffs of the Companies having their headquarters at Marconi House in subscribing to the new War Loan.

The entire sum required to meet applications for Stock will be advanced free of interest subject to such applications being approved by the Secretary, and to the subscribers undertaking to repay the amount so advanced by the Company within six or twelve months by weekly or monthly instalments deducted from his or her salary.

At a meeting of the staffs of the Marconi Companies, held at Marconi House on February 12th, Mr. Godfrey Isaacs, the managing director, announced as a further inducement that Marconi's Wireless Telegraph Co. would allow repayment to be made over two years in all cases where members of the staff took up a sum equal to at least 10 per cent. of their salaries. This proposal was received with enthusiasm, and a very large sum has been subscribed in this way.

Marconi's Wireless Telegraph Company have applied for £200,000 in the new loan, and the Marconi International Marine Communication Co., Ltd., for £50,000 (all new money).

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The Message, or "Pack Wireless"

Another thrilling War Story by "Perikon"

THE final inspection at the wireless depot is in full swing. Across the stretch of flat ground a small limbered wagon is careering, drawn by a four-horse team. Ahead and behind the swaying limber ride a posse of horsemen.

The glittering hubs and shining wheels are as clean as emery, "elbow grease" and "oil-preserving wood" can possibly make them. The horses have all the glossy satin coat which comes of decent treatment, feeding and grooming. The harness and saddlery glitter. Buckles, irons and bits gleam silver in the sun. The men themselves are spick and span, and sit their saddles well.

A number of whistle blasts, and the canter changes to a gallop. The cavalcade takes the prepared ditches and banks without slackening speed—the team horses straining into their breast collars and their traces taut. A second blast, and the troop halts abruptly. The team is swiftly unhooked, the "single mounts" are passed to the drivers and the horses move off in a bunch and "stand easy" some hundred yards off—snorting and blowing and generally having a breather.

The wagon is left with the station crew, who fall in smartly in the rear, and next second are busy "erecting station." Three minutes later the first mast is raised, stayed and secured. The second follows, and in a brief space there is a sudden roar and a hiss as the motor starts, and Number One depresses the transmitting key.

"Station ready and working—six and a half minutes—not so bad," remarks a dapper officer of Engineers standing some hundred yards off—"Dismantle." The order is conveyed by whistle blast, and eight minutes later the pack trots past *en route* for stables and dinner—the dreaded ordeal over and with the conviction that they've done well and will surely soon be across the Channel.

* * * * * *

Two weeks later sees the limber, then the trail, being swung aloft by a giant crane and swiftly lowered into the spacious hold of a "trooper." The horses are "'tween decks" with their saddlery on, but with loosened girths. The station crew are squatting on deck and doing their best to avoid the various white-hot steam pipes with which the decks of a tramp seem to abound, and in drawing their life-belts from the roomy chests on deck and elsewhere.

* * * * * *

Ten months later the advance guard of the 160th Corps rattles through the deserted little village. First a troop of lancers, then four wicked-looking Q.-F.'s with ammunition limbers apiece, and a couple of baggage and forage wagons behind. Then a small limbered wagon with a small posse of horsemen ahead, and behind—the wireless wagon. If you looked closely you'd recognise it as the same one you'd noticed at the home depot undergoing its final inspection. But there's a drastic

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change in everything. The wagon is encrusted in dry mud and dust, and small pieces of turf are adhering to wheel and limber. The horses have lost much of their satin, and the metal fittings of the harness no longer shine silver, instead they are thick in rust. No glittering buckles, irons or bits now. The men look thinner perhaps, and their stubbly beards and unwashed appearance almost convince you that they can't really be the same men. You note a difference—a vague something in their way of looking at one, and you decide they're *not* the same men.

Behind them another troop of grimy cavalry clatter—horses in a lather, and horsemen blue-chinned and hollow-eyed. For three days they've pushed on, pressing and worrying the rearguard of the crack East Prussian Corps directly opposed to them. The great retirement has begun and the Germans so far have conducted it in a swift and businesslike manner. Another twenty kilometres perhaps, and they'll swing round and make a stand, for the black-eagled frontier posts begin just beyond that—*then* there's a possibility of firework displays on a large scale. Meanwhile the grey Uhlans of the rearguard can sometimes be picked out with the naked eye crossing fallow, or silhouetted for a fleeting instant on the sky line.

The leading troop of our advance guard and the four wicked-looking Q.F.'s suddenly swing through a gap in the roadside hedge and canter in the direction of a small plantation. The rest of the cavalcade follows and halts in the shade of a row of tall elms. A "fleeting opportunity" target has offered itself in the shape of a dense blue-grey smudge toiling like a big lizard into the heat haze some two miles ahead. An instant later the Q.F.'s are showering them with douches of whining metal. Smoke obscures the lizard, but when it clears nothing can be seen distinctly by the naked eye—perhaps it's better.

We turn round and see the pack crew hurrying to and fro at the double, "erecting station," much as they did on the depot ground more than ten months ago. Important "stuff" must be got through to Corps' Headquarters, and that within the next fifteen minutes, for the seeming impossible has happened. The enemy has been strongly reinforced—Heaven knows how or from which quarter—and is turning and slowly crawling back in his tracks. Squadron after squadron of apparently fresh cavalry can be picked out deploying in extended order from spinney and hedgerow, looking much like hurrying ants at the distance. It means our advance guard falling back perhaps ten kilometres, unless at least a cavalry division and the Corps' "heavies" can be rushed up in time to meet the oncoming wave and send it staggering back. Two troops of the finest cavalry and four Q.F.'s of small calibre can do some considerable damage, but it's suicide to attempt to stem an entire enemy division equipped with well over thirty light pieces maybe.

The enciphered message goes hissing out into space, and a yawning operator at Corps Headquarters (a tumbledown farm some four miles in the rear) takes down the message group by group, hands it to his superintendent, and signals the pack to go on with his "stuff."

Meanwhile the Q.F.'s have abruptly ceased firing, and their teams are trotting over to move them. The cavalry outposts have galloped in. A ranging shell bursts over the trees a decent hundred yards to the right, and occasionally spent bullets go whining overhead. An orderly canters over to the wireless station, and

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next minute the masts are down and being packed, the aerial is running home on its drums, and the gear is being loaded.

Just as the orderly is gathering his reins to canter off, a giant billowy ball of saffron-hued smoke springs out of nothingness about ten feet off the ground, a deafening crash is heard—smoke and explosion occur at precisely the same instant. The orderly and horse appear to lift some three feet in the air and thud inert to earth. Three of the pack crew go down, ripped up in hideous strips. Two others attempt to get up and roll over with curious gurgles. They have crossed into calmer water. A horse shrieks and lies lashing at the lifeless carcase of his team-mate. The wagon is splintered and the fore limber is wrecked. Only three of the pack crew are unscathed. Smart gunners these enemy horse artillerymen—not exactly blacks. Suddenly the Q.F.'s limber up and gallop towards the gap in the hedge.

"Come on, you people, get a horse and move yourselves, their patrols are three fields off," yells a Major of Artillery.

"No time to repair"—the rest is lost in the rumble of limbers and the sog-sog of the hoofs. The pack crew hastily unstrap their axe and pickaxe and do a seemingly curious thing. They smash into the apparatus, and next second the shining fabric of ebony and nickel, of which they were so proud, lies in a tortured heap. A tin of petrol is ripped up and the pile drenched, a light applied, and a crimson tongue of flame shoots up, stationary messages, etc., are thrown on top. Two minutes later three horsemen are tearing down the poplar-lined pavé in the wake of the fastly moving Q.F.'s and cavalry. Mauser bullets hum and whine about their ears and occasionally crack into the poplars with loud whiplike snaps.

One grimy rider turns to his comrade: "Anyway we got *the* message through, and the swine can't use our gear—get up, Billy boy"—as his weary horse stumbles and picks up his stride again.

Three kilometres farther on a loud close-at-hand rumbling assails their ears—our heavies about a kilometre off by the sound. Suddenly the Q.F.'s halt, unlimber, and send salvoes of shell shrieking into the strung-out advance guard of the enemy. Our cavalry reinforcements have arrived, too. To right and left they can be seen streaming and deploying. Eighteen-pounders, too, battery on battery are coming up at the trot through stiff plough, and unlimbering and beginning to spit and cough. Machine guns rattle, rifles and carbines crack, riderless horses tear insanely and aimlessly in all directions. The enemy's patrols wheel round, and in a few minutes they can again be picked out, their squadrons lighter, hurrying into the shimmering haze, much like scurrying ants.

The Q.F.'s gallop back on their tracks in a fog of choking dust, a squadron of lancers, more horse artillery, another dragoon and hussar squadron, and cantering hot in their wake with limber and trail swaying, and an eddy of dust astern, another pack wagon clatters. Everybody looks fresher and cleaner than the advance guard. They've all come up in response to *the* message.

PERIKON.

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Correspondence

To the Editor of THE WIRELESS WORLD.

SIR,—I was very interested in the article given by Mr. Coursey, B.Sc., in your January number, on the calculation of inductances.

I think, however, that for comparison (on the plea of simplicity) between Nagaoka's formula :

$$L = \pi^2 D^2 n^2 lK,$$

quoted by Mr. Coursey, and Lorenz's :

$$L_s = an^2 Q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

or Raleigh's :

$$L_s = 4\pi an^2 X \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

quoted by me in the December issue, it would be more reasonable to give the comparisons using the three formulæ, either all corrected or all uncorrected.

Actually, there is then little difference between Mr. Coursey's results and mine, and that difference is more in the inaccuracy of working than that of the method. Thus Mr. Coursey (January issue, 1917, p. 789), quoting my first example (December issue, 1916, p. 672), gives : by Nagaoka's formula the result, 150,000 cms., which if worked out to more figures gives 150,550 cms., whereas taking my *uncorrected* figures

$$L_s = 47985{\cdot}77 \times \pi = 150{,}760 \text{ cms.}$$

Again, where he quotes my second example, if Nagaoka's formula be worked out to full accuracy using $K = 0{\cdot}471865$ (as given in the tables of the *Bulletin of Bureau of Standards*, vol. viii., 1912) the value of the uncorrected of L is 2,911,300 cms., whereas the value of L_s also uncorrected given in my example is 2,911,700 cms., which is naturally closer than taking my corrected value for comparison—namely, 2,901,620 cms. Taking K to three figures 0·472 would, therefore, be nearer than 0·471.

The same correction formula quoted by me—namely,

$$-\Delta L = 4\pi an\,(A + B)$$

applies to all these formulæ.

Of course, if the formulæ do not break down for the example taken, then the corrected or uncorrected values should agree, as I have shown they do.

The one advantage of Nagaoka's formula ($L = \pi^2 D^2 n^2 lK$) when Mr. Coursey's curves are available (*Electrician*, vol. lxxv., page 841) is that the function K carries the formula over a larger range than my Q or X alone.

I think even now that the two formulæ $L_s = an^2 Q$ and $L_s = 4\pi an^2 X$ are somewhat simpler, especially when the corrections are not applied. I might also mention that Rosa and Grover in the *Bulletin of Bureau of Standards* do not advise the use of Nagaoka's formula where the breadth is less than one-fifth the diameter, or where $\frac{2a}{b} < 0{\cdot}2$.

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It is for limitations of this sort that I have given two formulæ and two tables of functions to cover all ratios of diameter to breadth of coil likely to be encountered.

Yours, etc.,

BERTRAM HOYLE,

(Lieutenant R.N.V.R.).

H.M.S. *Excellent*,
January 19th, 1917.

Radiation Simply Calculated

To the Editor of THE WIRELESS WORLD.

SIR,—In your issue for January last an abstract is given on page 755 of an article on the above subject. It is rather interesting to note that from the formula given :

$$P = 640 \frac{h^2}{\lambda^2} \cdot I^2.$$

for a vertical-wire aerial, the radiation resistance of such an aerial, *when oscillating at its natural frequency*, is independent of its height. For in such a case we have :

$$\lambda = 4h, \text{ nearly,}$$

Hence radiation resistance

$$R = \frac{P}{I^2} = 640 \frac{h^2}{16 h^2}$$
$$= 40 \text{ ohms.}$$

This means that any vertical-wire aerial radiating its natural wave-length has a radiation resistance of 40 ohms. It is clear that this result is owing to the fact that a diminution of radiating power due to a reduction of height is exactly counterbalanced by an increase due to the higher frequency at which the aerial oscillates.

Another point of interest regarding the two different formulæ given for (1) a flat-topped aerial and (2) a vertical wire aerial is that these two formulæ become identical if we take h as being the height of centre of capacity (*see* Austin in *The Electrician*, November 19th, 1916, page 246), instead of height of aerial. For case (1) these two heights are practically identical, but for case (2) the centre of capacity is equal to $2/\pi$ X height of wire. Hence if we substitute $\frac{\pi}{2} \cdot h$ for h in the second formula we get :

$$P = 1575 \frac{h^2}{\lambda^2} \cdot I^2$$

or substantially the same as in the first formula.

Yours, etc.,

R. C. CLINKER.

January 18th, 1917.

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Some Notes on Aerials

By W. D. LACEY

In the construction of aerials several considerations are involved, and it is the object of the writer to present these in their clearest form, together with the compromise effected between this advantage and that disadvantage of the various materials available for use.

The operator at sea has no choice of material, but the considerations which led to the selection of his various wires and insulators will be instructive.

During the course of the writer's experience several different aerial wires have been tried, varying from copper, phosphor bronze, steel copper clad and enamelled, and lastly, silicon bronze.

From the point of view of electrical efficiency there appeared to be no practical difference between one or the other, but doubtless with suitable testing apparatus (which is not available to the operator at sea) different efficiencies could be tabulated for each of the above mentioned materials.

One of the first considerations, then, is the mechanical strength of the wire, but we immediately find that another essential condition is a high conductivity, so that we may tabulate our available materials as follows :—

Material	Tensile Strength Tons cub. cm.	Conductivity Per cent.
Hard drawn Copper	14	100
Hard drawn Silicon Bronze	40	42
Hard drawn Phosphor Bronze	50	28

Evidently then copper would appear to be the best conductor, but it is too soft to use in positions where it would be subjected to strains. It is found with copper aerial wires that they gradually stretch, and eventually break at a point where the wires have become thin.

Phosphor bronze would be the most preferable from the point of view of strength, but its conductivity as compared with copper is low, therefore the best compromise is to select silicon bronze, which has nearly the same tensile strength as phosphor bronze, and nearly twice its conductivity.

The breaking strain of the 7/19 silicon bronze wire used for aerials is about 900 lbs., but to allow for windage and general deterioration it is not good practice to set up the aerial to a greater tension than 100 lbs. per wire.

In order to ensure perfect conductivity for feeble received oscillations it is necessary to solder all joints in the wire, otherwise a high resistance film of oxide will form at the joint, which might even insulate a portion of the aerial for weak oscillations.

We find, however, that when a hard drawn metal is soldered, owing to the effect of the heat, its tensile strength is very much reduced, so that it is inadvisable to put any severe strain on the joint.

To obviate this difficulty a special method of jointing has been devised, which is shown in the accompanying sketch (Fig. 1).

Therefore so far as possible no part of the aerial under strain is subjected to the

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heat of soldering, but it is found necessary to solder the seizings at the ends of the wires in preference to splicing, where thimbles are made fast.

It is found that the wire simply bent round the thimbles, seized and soldered in three places with four or five turns of No. 20 solt annealed copper wire, is as strong as the wire itself.

Reference to the diagram on page 937 will make this clear.

In making soldered joints great care must be taken not to leave any points exposed at the ends of the aerial wire itself, or its seizing wire. as this would cause loss of energy by brush discharges.

INSULATION OF AERIALS.

In the matter of the selection of insulators very much the same considerations are involved between mechanical strength and good insulating qualities.

Good insulation is of the utmost importance, as poor insulators mean leakage and loss of power. The effect of bad insulation is to increase the damping, so that in addition to loss of power the tuning is flatter.

The loss of energy due to leakage is less in the case of loosely coupled circuits than in the case of close coupling, so that in a directly excited aerial (plain aerial), the loss due to leakage may quite easily represent nearly all the energy supplied to the aerial.

From this we see the first essential to consider is the dielectric strength of the material.

The following table shows the dielectric strength of the different substances which are suitable for use :—

Material.	Voltage required to puncture 1 cm. thickness.
Ebonite	500,000
India Rubber	450,000
Glass	250,000
Porcelain	100,000

The next point to consider is the surface insulation.

At high voltages electricity will creep over the surface of a perfectly dry insulator far more readily than it will spark through the substance. In restricted positions it is usual to corrugate the insulator in order to increase the surface distance between its extremities, but in the case of aerials the space is not usually limited, and therefore a straight insulator can be used, long enough to ensure freedom from serious leakage.

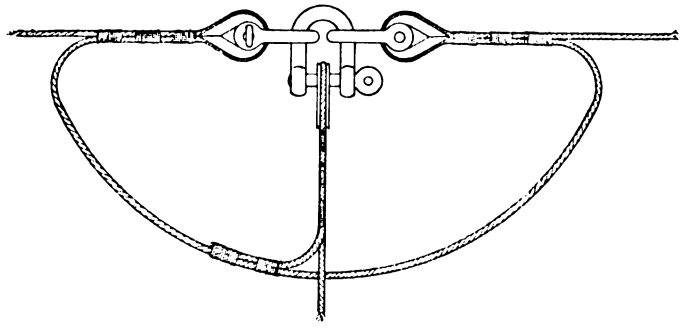

FIG. 1.

For dry insulators about 4 cm. of surface length is allowed for every 30,000 volts, but in the case of aerial insulators where dirt

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and moisture accumulate long insulators are necessary in order to maintain sufficient insulation.

In this connection it is well to remember that dirt accumulates slowly, and trouble from this source can be avoided by periodical inspection and cleaning.

It is good practice to have two sets of insulators in use, so that when the aerial is lowered the spare set can be attached in the minimum of time, and the other set cleaned at leisure.

(This does not mean putting the insulators away and forgetting them until they are required for use again.)

In marine installations there are three different types of insulators in use, viz., 3 feet waterproof flexible rubber strop, 3 feet ebonite sheathed strop, and 40 inch ebonite rods.

FIG. 2.

The 3 feet waterproof is built up of an endless strand of Palmer cord laid up into a strop, seized along the shank, covered with a continuous skin of rubber, vulcanised, and fitted with a thimble at each end.

The working load of this insulator is 15 cwt.

The 3 feet ebonite insulator is similar, but encased in an ebonite tube fitted with anti-sparking discs, and screwed on end caps carrying a lug attachment for fitting a shackle.

The 40 inch pair of ebonite rods consists of two 20 inch by $\frac{3}{4}$ inch ebonite rods fitted with screw eyes at the ends, and linked together. The ends of the rods are seized with wire to prevent bursting, and one of the rods is fitted with a light cone to protect it from moisture.

This insulator will stand loads up to 10 cwt., but owing to the brittle nature of ebonite, the load should not exceed $\frac{3}{4}$ cwt.

The principal use of this insulator is to secure the down leads and steadying lines of the aerial, and in these positions heavy strains do not often occur.

Another type of insulator in use on coast stations is a highly vitrified porcelain rod, two feet between eyelets and one inch in diameter.

So long as the glaze remains perfect these insulators maintain a very high insulation, but they accumulate moisture from the air owing to the hygroscopic property of porcelain.

Measurements taken by the writer on an aerial fitted with these insulators showed variation of resistance between 80 megohms and 100,000 ohms in a few hours, although no rain had fallen in the interval between the tests.

The hygroscopic property of glass is very much greater than that of porcelain, and for this reason glass is never used as an aerial insulator; in fact even in dry positions indoors when glass is used it is usual to stand it in oil cups.

As far as possible insulators in an aerial should not be placed in parallel, as each additional insulator so used is an additional path over which leakage can take place.

It should be remembered that the resistance of an insulator to an alternating potential is less than its resistance to direct current voltage.

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SPREADERS.

The most suitable wood for spreaders is ash, on account of its flexibility and great strength combined with lightness.

The standard size spreader for ship installations is 12 feet 6 inches in length, 3 inches diameter at middle tapering to 2 inches at ends.

They are fitted with double lug steel bands 3 inches from each end, to which are attached the aerial insulators, thus spacing the aerial wires 12 feet apart.

The bridle is generally made of 2½ inch hemp rope, and is fitted with a thimble and shackle at each end for attachment to the lugs of the spreader bands.

The bight of the bridle is provided with a thimble for attachment to the halyard.

The distance from the bight of the bridle to the middle point of the spreader should not be more than 6 feet, nor less than 3 feet.

It will be seen, therefore, that the materials employed in the construction of present day aerials are the result of long and careful experiment under actual working conditions.

There is still room for improvement in the matter of insulators, as the conditions under which aerial insulators are used demand the utmost efficiency under the most trying circumstances.

They have to withstand all extremes of temperature, varying degrees of humidity, the corrosive action of sulphur fumes from the ship's funnel, rain and salt spray.

They must withal have excellent insulating qualities, and be mechanically strong.

Under certain circumstances the material of which the aerial wire is made is varied, as in the case of large fast ships, where there are excessive strains in heavy weather, and greater deterioration from the heat and fumes from the funnels. In such cases heavy steel copper clad enamelled wires are used, the enamel giving very great protection from the corrosive fumes.

New U.S. Army Wireless Stations

Guarding the Mexican Border

AUTHORISATION has been given for the erection of powerful radio stations at Laredo, El Paso and Fort Huachuca, Ariz. These will be a type similar to the wireless station at Fort Sam Houston, but of greater receiving radius, and will give the army a complete system of radio-communication along the Mexican border from Brownsville to the Pacific Coast.—(*The Electrical Experimenter.*)

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Among the Operators

The German Piracy Campaign.

At the time of writing the new German piracy campaign has been in full swing for some little time. Far from frightening our gallant sailors, it has, if possible, steeled them still more strongly in their resolve to fight with all the means at their disposal against the now desperate enemy. The wireless operators, as usual, are carrying out their work nobly, and with their instruments are proving the means of saving hundreds of lives each week.

OPERATOR H. SPROAT.

On board the *California*, the large Anchor liner recently torpedoed without warning, the two operators were H. Sproat and W. Craven. Mr. Hew Sproat is of Scotch birth, and is now in his thirtieth year. Born at Ayr, he was educated at Ayr Academy and the Glasgow and West of Scotland Technical College. On completing his studies he became an engineer, and later left this profession to study wireless telegraphy at the Liverpool Wireless Telegraph Training College, where he obtained his Postmaster-General's certificate. Entering the Marconi Company in July, 1913, he was appointed to the staff, and sailed first on the s.s. *Lancastrian* and was later transferred to the s.s. *Caledonia*. He then served on a number of other ships, and held the position of senior operator on the ill-fated *California* for a good many voyages before she was sunk. We are very pleased to say that he was saved from the wreck, and to the best of our knowledge sustained no injury of any kind.

The junior operator, Mr. Walter Craven, is 18 years of age, and comes from Newcastle-on-Tyne. After leaving school he studied wireless at the North Eastern School of Wireless Telegraphy at Newcastle, where he obtained his certificate. He joined the Marconi Company quite recently, and the *California* was his first ship. Mr. Craven was also among the saved, and we trust he will be more fortunate on the next vessel to which he is appointed.

OPERATOR W. CRAVEN.

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OPERATOR S. TAIT.

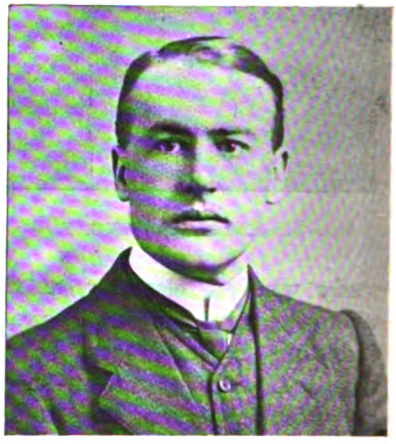
S.S. "ARTIST."

We regret to announce that Mr. Sidney Tait, operator of the s.s. *Artist*, which was torpedoed and sunk in January, is reported missing, and is feared to have lost his life. Mr. Tait, whose home was in Edinburgh, was 20 years of age, and studied wireless at the North British Wireless School, Edinburgh. He entered the Marconi Company's London School in January, 1915, and was shortly afterwards appointed to the s.s. *Star of India*. From this ship he transferred to the s.s. *Atlantia*, and then served successively on the *Cymric* and the *Inca*, transferring to the *Artist* in January of this year. Deep sympathy is felt with the late operator's parents in their sad bereavement.

* * * * * *

PRISONERS OF WAR.

In a few cases the wireless operators and other officials of ships sunk by the German raider have been made prisoners of war. This is the case with Messrs. James Young and Edward Alan Godsell, of the s.s. *Georgic*, sunk recently. Mr. Young was born near Newcastle-on-Tyne, and is now in his thirtieth year. After leaving school he entered business, and later took a course of training in wireless at the British School of Telegraphy. In April, 1913, he entered the services of the Marconi Company, and after a short period in their training school was appointed to the s.s. *Caronia*. He afterwards served on several vessels, including the s.s. *Irishman*, on which he made a number of trips, and was appointed to the s.s. *Georgic* at the end of last year. We sincerely trust that he will receive good treatment, and that he will soon be back in his home country again.



OPERATOR J. YOUNG.

OPERATOR E. A. GODSELL.

Junior operator Mr. E. A. Godsell, who was also taken prisoner, is a comparatively new recruit to the wireless service, having joined the Marconi Company only a few months before the *Georgic* was sunk. Born in County Cork in 1890, he received his education in that district, and after leaving school entered upon a

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THE LATE OPERATOR W. S. LUCA.

business career. Later he studied wireless as an evening student at the Irish School of Telegraphy, Cork, and obtained his Postmaster-General's certificate at that place. On entering the Marconi Company he was appointed to the s.s. *Georgic*, which was sunk on his first voyage. Mr. Godsell we hope will also be well treated and soon return safely.

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S.S. "FLORIDIAN."

In the case of the sinking of the s.s. *Floridian* the senior operator, Mr. A. R. Beynon, was taken prisoner, but the junior operator, Mr. W. Seaton Luca, lost his life. The late operator was but 17 years of age, and was born at Liberton, near Edinburgh. After leaving school he took a course of training at the North British Wireless Schools, Edinburgh, where he obtained his Postmaster-General's certificate. He joined the Marconi Company in July last, and was appointed almost immediately to the s.s. ***Floridian***, on which vessel he remained until she was sunk. Sincere sympathy is felt for the late Mr. Luca's parents in their sad bereavement, the sorrow for which will be tempered by a pride in knowing that, although so young, he died nobly in the services of his country.

OPERATOR A. BEYNON.

Mr. Austin Reginald Beynon, the senior, who was fortunately saved, hails from Cardiff, where he was born in 1893. On leaving school he held a clerical position for some time, and then turned his attention to wireless telegraphy and studied at the British School of Telegraphy. In 1912 he entered the services of the Marconi Company, his first ship being the s.s. *Franconia*, from which he transferred to the s.s. *Corsican*, and afterwards to the s.s. *Canadian*. Later he served on the s.s. *Ansonia*, s.s. *Kanawha*, s.s. *Lake Michigan*, receiving his appointment to the s.s. *Floridian* in July last. We trust he will be well treated.

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A Simple Geometrical Construction

By S. LOWEY

THE joint resistance of a number of resistances in parallel is equal to the reciprocal of the sum of the reciprocals of the individual resistances.

Two resistances of a ohms and b ohms connected in parallel have thus a joint resistance of

$$\frac{1}{\frac{1}{a}+\frac{1}{b}}=\frac{ab}{a+b} \text{ ohms.}$$

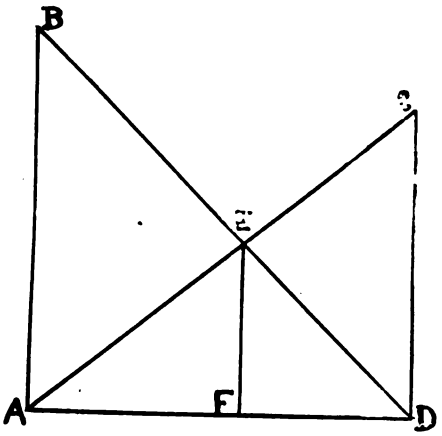

FIG. 1

This may be solved by a simple geometrical construction which, while not new,* is worthy of being made more widely known.

In Fig. 1 AB and CD are drawn perpendicular to AD and represent to a scale the resistances of the two conductors. (This may be done very easily on squared paper.)

Join AC and BD, and from the point of intersection E, draw EF perpendicular to AD. The length of EF to the same scale gives the joint resistance in parallel of the two resistances.

The problem may be proved very easily, as follows, the lines being marked as in Fig. 2 :

$$\tan\theta=\frac{x}{m}=\frac{b}{s} \therefore b=\frac{xs}{m}$$

$$\tan\phi=\frac{x}{n}=\frac{a}{s} \therefore a=\frac{xs}{n}$$

The joint resistance

$$\left(\frac{ab}{a+b}\right)=\frac{\frac{xs\times xs}{mn}}{\frac{xs}{n}+\frac{xs}{m}}=\frac{x^2s^2}{mn}\times\frac{mn}{xs\,(m+n)}=$$

$$\frac{x^2s^2}{mn}\times\frac{mn}{xs\,(m+n)}=\frac{x^2s^2}{mn}\times\frac{mn}{x.s.s}$$

$$=x. \quad Q.E.D.$$

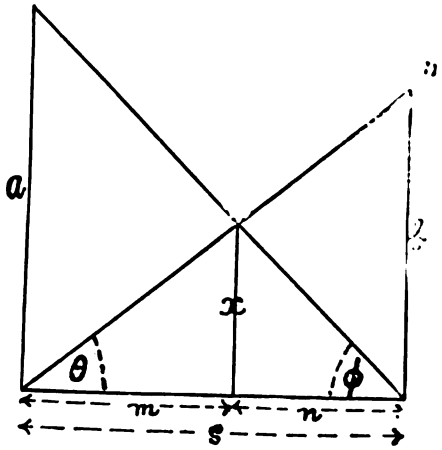

FIG. 2

* The writer was first introduced to this method at Liverpool Central Technical School (about 1902) by J. E. Lloyd Barnes, Whit.Sch., who was then lecturer in electrical engineering.

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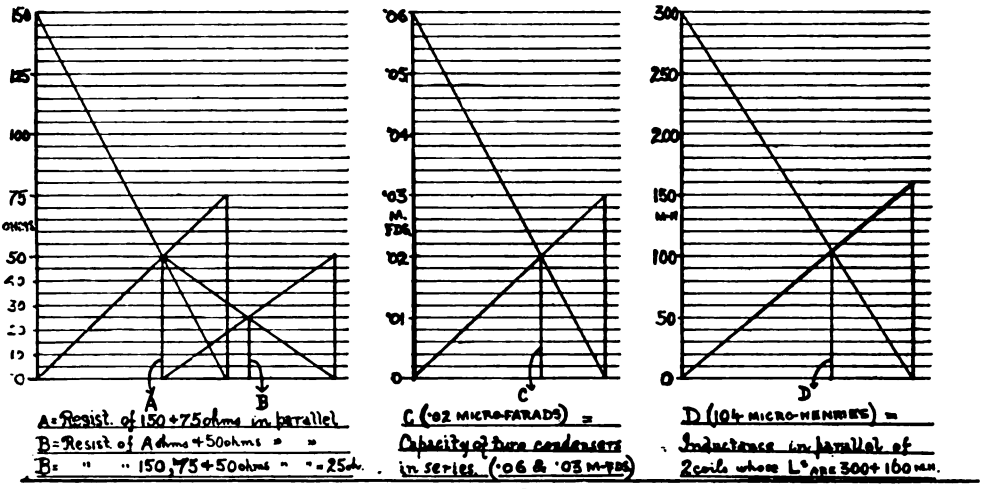

FIG. 3

The formula for joint resistance may be applied to find the capacity of condensers in series, and also to inductances in parallel, providing that the mutual inductances of the coils is negligible.

If two or more operations are being performed by the graphical method, the joint resistance of two conductors is taken as one resistance in dealing with the third conductor, and so on for any number of conductors.

Several examples are given in Fig. 3, which scarcely need further description.

Wireless to Help United States Forest Service

ACCORDING to the *Electrical Experimenter*, the U.S. forest service will probably use wireless telegraph in extending its communication system in New Mexico and Arizona as a result of an experiment held on the Apache national forest of Arizona.

The forest service would not supplant its telephone and telegraph lines by wireless. That, of course, would mean unnecessary expense. Wireless would be used in connection with the present system, which provides communication between the district headquarters and all forest supervisors. Rangers, however, cannot always be reached by this means, and therefore wireless would be very useful.

Wireless may also be used instead of telegraph lines which the forest service plans to build. Cheapness of construction and maintenance in comparison with wire systems is a great recommendation.

District Forester Paul G. Redington, speaking of the experiment, explained how a message was sent from the Baseline ranger station by wireless to a station at Clifden, Ariz, forty miles away. This is believed to have been the first wireless message sent from a ranger station in the United States.

The Baseline plant was installed by Ranger William R. Warner and Ray M. Potter, at a cost of $75. The project was conceived by Ranger Warner. Mr. Redington was in the station when the message was sent. It was relayed by wire to the district headquarters.

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The Resistance of the Wheatstone Network

By A. F. BURGESS, B.Sc.

THE system of conductors generally known as the Wheatstone bridge network has such important uses that many of its peculiarities are very well known. For ordinary purposes the network is of the greatest interest when "balanced"; this condition is satisfied when the ratio of the resistance arms $p : q$ is equal to the ratio $r : s$ (see Fig. 1). Thus, for example, when q and r are interchanged, the product qr is still equal to ps, so that the balance is unaffected by joining the battery to the G corners and g to the B corners. Again, when the arm r is a galvanometer and g a simple resistance or equivalent, an alteration in the value of g from zero to infinity produces no change in the current distribution, and the galvanometer deflection is unchanged—Kelvin or Thomson test. Further, r may be a battery, g a galvanometer, and a resistance across the B corners may be altered from zero to infinity without changing the galvanometer reading—Mance test.

But the "unbalanced" network has also some interesting properties; one of these, the effective resistance of the system between the B corners, will be considered here.

To calculate this resistance assume that one ampere flows in at B_1, see Fig. 1, of which x amperes go along p to G_1, where the current again divides and y amperes flow along g. Then applying the Kirchoff laws, we may write expressions for the P.D. between B_1 and B_2, which will be equal to the equivalent resistance of the network:

$$R = px + q(x-y) = r(1-x) + s(1-x+y)$$
$$= px + gy + s(1-x+y).$$

When rearranged these equations become:

$$(p+q) \cdot x - q \cdot y = R$$
$$-(r+s) \cdot x + s \cdot y = R - (r+s)$$
$$(p-s)x + (g+s) \cdot y = R - s$$

and these by the ordinary methods yield the solutions:

$$x = \frac{(r+s)\,g + r(q+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)}$$

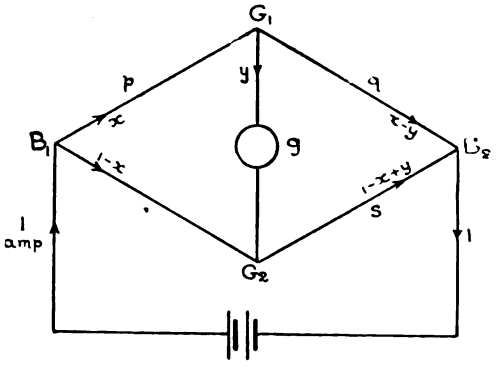

FIG. 1.

and

$$y = \frac{(p+q+r+s)\,r - (p+r)\,(r+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)} \quad \text{or} \quad \frac{qr-ps}{(p+q+r+s)\,g + (p+r)(q+s)}.$$

Then

$$R = (p+q) \cdot x - q \cdot y.$$
$$= \frac{(p+q)\,(r+s)\,g + (p+r)\,(qs) + (pr)\,(q+s)}{(p+q+r+s)\,g + (p+r)\,(q+s)} \quad \ldots\ldots \quad (1.$$

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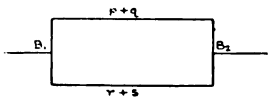

FIG. 2.

which may also be written in the form

$$R=\frac{m_1 g+m_2}{n_1 g+n_2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $m_1=(p+q)(r+s)$ $m_2=(p+r)qs+pr(q+s)$
$n_1=(p+q+r+s)$ $n_2=(p+r)(q+s)$

This form (2) is of interest because it can be so easily obtained from the following considerations.

If g is very large, the value of R becomes $R_1=\frac{m_1}{n_1}$, and the diagram simplifies to that of Fig. 2, from which the value of R_1 may be easily found.

Again, if g is very small, the value of R becomes $R_2=\frac{m_2}{n_2}$, and the diagram becomes that in Fig. 3.

Thus, by first performing the simple calculations necessary for these two extreme cases, the equivalent resistance for any value of g may be at once written down. One important point must, however, be noticed, so a numerical example will be given.

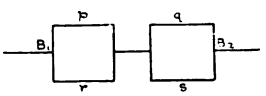

FIG. 3.

Let $p=10$, $q=2$, $r=2$, $s=10$ ohms and $g=5$ ohms. Referring to Fig. 2, R_1 will be $\frac{(10+2)(2+10)}{(10+2)+(2+10)}=\frac{144}{24}$. *Note* that this result must not yet be simplified. Also, referring to Fig. 3

$$R_2=\frac{10\times 2}{10+2}+\frac{2\times 10}{2+10}=\frac{20}{12}+\frac{20}{12}=\frac{240+240}{144}=\frac{480}{144}.$$

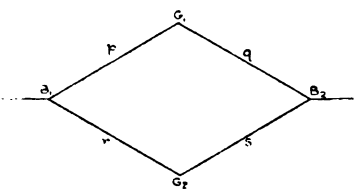

FIG. 4.

Again *note* that the "long" method of adding fractions *must* be used here as in the general case. Then the equivalent resistance when $g=5$ ohms is

$$R=\frac{5\times 144+480}{5\times 24+144}=4.55 \text{ ohms.}$$

EFFECT OF INTERCHANGING CONNECTIONS TO *B* AND *G* CORNERS.

Consider next the resistance of the network between the *G* corners. Fig. 4 is transformed to Fig. 5—*i.e.*, the arms q and r are interchanged. The value of R_1 in Fig. 2 was

$$\frac{m_1}{n_1}=\frac{(p+q)(r+s)}{p+q+r+s};$$

this now becomes

$$R_1{}^1=\frac{(p+r)(q+s)}{p+q+r+s}=\frac{n_2}{n_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Also the value of R_2 as determined from Fig. 3 is changed from

$$\frac{m_2}{n_2}=\frac{(p+r)qs+pr(q+s)}{(p+r)(q+s)}$$

to $R_2{}^1=\frac{(p+q)rs+pq(r+s)}{(p+q)(r+s)}$

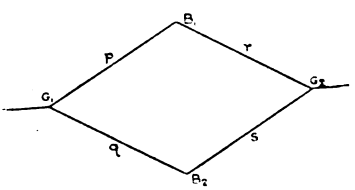

FIG. 5.

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which is equal to

$$\frac{(p+r)\,qs+pr\,(q+s)}{(p+q)\,(r+s)} \text{ or } \frac{m_2}{m_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Therefore the equivalent resistance between the G corners when the B corners are connected by a resistance g, obtained from formulæ (3) and (4), is

$$R^1=\frac{gn_2+m_2}{gn_1+m_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

This result may be obtained from formula (2) by interchanging m_1 and n_2.

Further, the ratio $\frac{R_1^1}{R_1}=\frac{(p+r)\,(q+s)}{(p+q)\,(r+s)}$; also the ratio $\frac{R_2^1}{R_2}=\frac{(p+r)\,(q+s)}{(p+q)\,(r+s)}$, so that $\frac{R_1^1}{R_2^1}=\frac{R_1}{R_2}$. That is to say, the percentage change in resistance between the G corners when the arm between the B corners is altered from 0 to ∞, is the same as for the B corners when the arm between the G corners is similarly treated.

THE EFFECT OF ALTERING THE VALUE OF g FROM ZERO TO INFINITY.

In the original figure

$$R_1=\frac{m_1}{n_1}=\frac{(p+q)\,(r+s)}{p+q+r+s} \text{ and } R_2=\frac{m_2}{n_2}=\frac{(p+r)\,qs+pr\,(q+s)}{(p+r)\,(q+s)}$$

therefore,

$$R_1-R_2=\frac{(p+q)\,(r+s)\,(p+r)\,(q+s)-[(p+q)+(r+s)]\,[(p+r)\,qs+pr\,(q+s)]}{(p+q+r+s)\,(p+r)\,(q+s)}$$

which is found to simplify down to

$$\frac{(ps-qr)^2}{(p+q+r+s)\,(p+r)\,(q+s)}.$$

Therefore, the change of resistance, due to change in g from 0 to ∞, expressed as a fraction of R_1—*i.e.*,

$$\frac{R_1-R_2}{R_1}=\frac{(ps-qr)^2}{(p+q)\,(q+s)\,(s+r)\,(r+p)}.$$

Obviously if the network is "balanced" $ps=qr$, and the effect of short-circuiting the G corners is nil. For the "unbalanced" network the effect depends to a large extent on the out-of-balance term $(ps-qr)$. For example, if p and q are each equal to a, and $r=a(1+x)$, $s=a(1-x)$, then $(ps-qr)^2=4a^4x^2$; also $(p+q)\,(q+s)\,(s+r)\,(r+p)=2a\,.\,a\,(2-x)\,.\,2a\,.\,a(2+x)=4a^4\,(4-x^2)$. Under these conditions $\frac{R_1-R_2}{R_1}=\frac{x^2}{4-x^2}$, and if the network is nearly in balance x is small and the fractional change of resistance is proportional to x^2—*i.e.*, to the square of the "out-of-balance."

When the value of g lies somewhere between 0 and ∞ the value of R is obviously between R_1 and R_2. From (2),

$$R=\frac{m_1g+m_2}{n_1g+n_2} \text{ and } R_1=\frac{m_1}{n_1},$$

so that

$$\frac{R_1-R}{R_1}=\frac{m_1n_2-m_2n_1}{m_1n_1g+m_1n_2},$$

where $(m_1n_2-m_2n_1)$ is $(ps-qr)^2$ as previously found. The following table shows some particular cases, the fraction being expressed as a percentage for various

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values of g. It will be noticed that when three of the arms are of similar resistance, the percentage change is fairly low, but is very high when the network is badly out of balance.

			$g=$	00	1,000		100		10		0	
p	q	r	s	R_1	R	%	R	%	R	%	R_2	%
1,000	1,000	1,000	10	671	606	9·7	531	20·8	512	23·7	510	24
10	10	10	1,000	19·6	19·52	0·4	18·83	3·9	16·5	15·8	14·9	24
1,000	10	10	1,000	505	342	32·3	100	80·2	29·2	94·3	19·8	96·2

Our New Volume

Important Announcements

WITH this issue the fourth volume of THE WIRELESS WORLD comes to a close, and we confess it is with a feeling of pride that we look back upon our achievements. In spite of the greatly increased difficulties of production, the closing down of all amateur stations and the cessation of all private wireless research, we can claim a steadily rising circulation and the retention of a circle of readers with whom we are proud to be in touch.

Next month, on receiving their copies of THE WIRELESS WORLD, our readers will find it presented in a bright new cover, highly artistic in design, which has been prepared for us by the well-known artist, Mr. J. W. Nicolson. With regard to the contents, whilst no great changes can be made in the present stress of war, the quality will be fully maintained and a number of minor improvements introduced. Of these we shall have more to say in our next month's pages.

A valuable new series of instructional articles dealing with Alternating Current will begin with the April issue, and will be written by a wireless expert who will lay particular emphasis upon those portions of the study which have most practical use to the wireless man. In arranging these series we have been largely influenced by correspondence we have received from a number of our readers who are anxious to study alternating current work. We would take this opportunity of pointing out that THE WIRELESS WORLD Instructional Articles are kept right up-to-date as the months go by. In this way our readers receive a type of instruction unobtainable elsewhere.

The last but not the least important announcement we have to make is that in future THE WIRELESS WORLD will be published on the 25th of each month, the April number thus being on sale on the 25th of March. Readers will do us a great service in reminding those of their friends who are not yet readers that the April number affords an excellent opportunity to commence their subscriptions.

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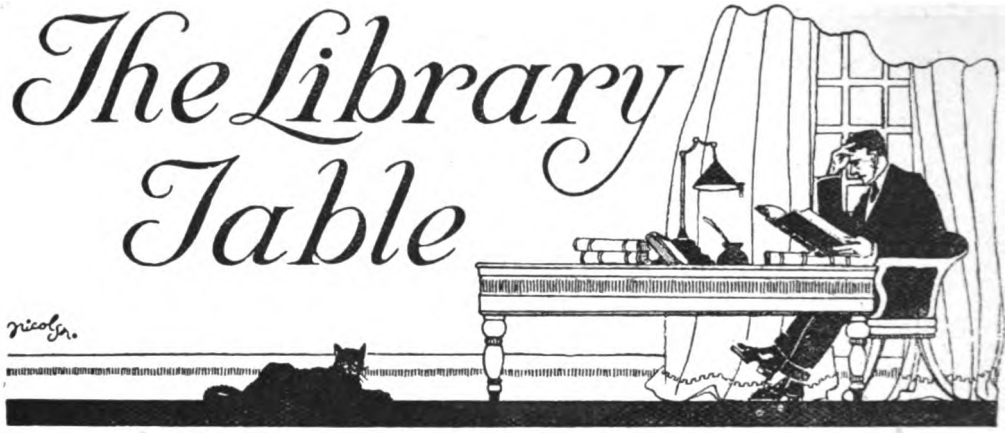
The Library Table



"THE 'PRACTICAL ENGINEER' MECHANICAL POCKET BOOK AND DIARY, 1917." London: The Technical Publishing Co., Ltd. 1s. 6d. net.

"THE 'PRACTICAL ENGINEER' ELECTRICAL POCKET BOOK AND DIARY, 1917." London: The Technical Publishing Co., Ltd. 1s. net.

The operator who wishes to make good progress in his profession must go through life continually acquiring information. Generally speaking, the more he learns about electrical and engineering subjects the greater interest he will take in his work and of greater value will he become to the firm employing him.

The two little books before us—really pocket books and not bulky volumes masquerading under that name—contain a vast store of thoroughly sensible and practical information on a great number of subjects of interest to the wireless operator, and their careful perusal in spare hours cannot fail to be of great benefit to the average man. We take pains to point this out for the reason that we are constantly receiving in our "Questions and Answers" section letters from sea-going operators making inquiries regarding many points clearly explained within these little volumes.

The Mechanical Pocket Book, containing more than 600 pages of literary matter, besides the diary, treats of steam, steam generators, various types of engines, turbines, etc., gas and oil engines (a valuable section for the wireless man), mechanical engineering materials, pipes, girders, etc., and much else of an engineering nature. We must not omit to mention the notes on the choice and use of lubricants, and for the business man there is a useful "Buyer's Guide" in French, Spanish and Russian.

The Electrical Pocket Book, which is, of course, the more valuable of the two from the point of view of the wireless man, deals with conductivity and resistance circuits and systems of wiring, measuring instruments, alternators, transformers, converters, accumulators, electric lighting, electric furnaces, and many other branches of electrical engineering. There is a useful little section devoted to wireless telegraphy in which the subject is treated in a lucid fashion without the over-loading with out-of-date material which so often figures in such sections. The various wire tables included in the book will be found very useful by all who have any work connected with electrical wiring, and the section devoted to general information contains in a handy form many tables which are needed almost daily. Altogether the editors and publishers of these two handy books are to be congratulated on the excellence of their production.

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"SEA POWER." By Archibald Hurd. Constable & Co. 1916.

Mr. Hurd's special qualifications with regard to naval matters render his little book of more than usual interest. It only runs to a matter of 94 pages; but we venture to say that the outline which he has been able to sketch within so short a space forms an excellent basis for the general reader upon which he can with advantage build up a more important perception of the value and working of sea power.

After a passing reference to the way in which Admiral Mahan was first attracted towards this subject, which afterwards became so peculiarly his own, Mr. Hurd proceeds to sketch the history of British sea power from the times of the coracles of the Ancient Britons to the present day. His comparison between the situation of England in the great Continental struggle with Napoleon with that which she now occupies in the international struggle against Prussian domination is particularly *apropos* at the present moment. The main points telling for or against the two distinct policies followed by England in the Napoleonic wars and in the present struggle, constitute an admirable illustration of how a study of history is essential for the proper consideration of current events. And the earlier part of his book must be gone through very carefully before the full bearing of his remarks can be realised.

There are many omissions, of course; it is not possible to compress the contents of a whole library into 94 pages; but, on the whole, the essentials are here. One interesting and not insignificant detail which appears to have escaped Mr. Hurd's observation occurs in Chapter IV., when he is dealing with the defeat of the Spanish Armada. The warning that Spain's mighty argosies, so long held up, were rapidly approaching our shores is correctly ascribed to Captain Fleming; but Mr. Hurd has omitted to mention that this gallant Scotsman was at the time in command of what our Elizabethan ancestors knew as "Moorish Corsairs." He was one of a band of patriotic English sailors, who, in order to "singe the King of Spain's beard," had placed their skill at the disposal of the Moors. These latter had been especially incensed against the Spaniards and Portuguese by the recent expulsion of the Moriscos from Spain and were burning for revenge. The Moors themselves had never been anything more than boatmen, and owed such seamanship as they acquired to the leadership and training of British sailormen.

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"THE FLYING MACHINE FROM AN ENGINEERING STANDPOINT." By F. W. Lanchester, M.I.C.E., M.I.M.E., M.Inst.A.E. London: Constable & Co., Ltd. 4s. 6d. net.

Whilst a great deal has been written on the subject of flying and flying machines, it is safe to say that few books of an authoritative nature have so far appeared. In this class, however, must be placed the book before us.

Mr. F. W. Lanchester, who has closely followed the progress of aviation and contributed to our knowledge of the subject from its earliest days, is well known as a member of the Advisory Committee for Aeronautics. This volume is a reprint of his "James Forrest" Lecture delivered before the Institution of Civil Engineers three months prior to the outbreak of war. In addition, there is included a discussion concerning the "Theory of Sustentation and the Expenditure of Power in Flight," being a paper presented at the meeting of the International Engineering Congress in San Francisco in 1915. It is true, as the author points out in the preface, that since

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the outbreak of war, from considerations of national secrecy, very little of a technical character has been added to the stock of public information, and for this reason the position existing immediately prior to the war has become a matter of more permanent interest than the author anticipated at the time his lecture was prepared. He has, therefore, revised the lecture and brought it out in book form.

A perusal of this book immediately brings home to the reader the enormous progress which has been made in aeronautical research during the last few years. In writing a book with the object of dealing with those problems in mechanical flight which come more directly within the purview of the aeronautical constructor, Mr. Lanchester has not attempted to deal with matters such as the theory of stability; the result of existing investigations have been assumed as established facts. In the first few pages we find a general consideration of the flying machine as an instrument of locomotion, its limitations being carefully considered. Now that the project for a transatlantic flight by aeroplane has been revived it is interesting to turn to the author's consideration of this problem. In 1914, at all events, such a flight would, according to Mr. Lanchester, be practically impossible, unless constant air current in the right direction could be relied upon to assist.

Among the subjects dealt with are "Catastrophic Instability," "The Laws of Resistance," "Propulsion," "Dynamic Load-Factor and Factor of Safety," "Landing Gear," and "Stability and Control." Under the heading of "Propulsion" some highly interesting facts are given regarding the propeller. Whether we appeal to experience or to theory, says Mr. Lanchester, it would appear that there is only one method of propulsion available—namely, the screw propeller. In a footnote it is pointed out that nature's method of propulsion—wing flapping—besides being very objectionable from a mechanical point of view, shows certainly no higher degree of mechanical efficiency than the screw propeller.

It is interesting to note that, roughly speaking, the conditions of usage of propellers in water and air may be compared by merely taking cognisance of the relative densities of the two media—approximately 800 to 1. It has been frequently said that the theory of the screw propeller is entirely empirical and quite unsatisfactory. Mr. Lanchester does not hold this opinion, and states that the theory of the screw propeller based on the theory of the aerofoil as laid down in *Aero-Dynamics*, appears fully to meet the requirements of the aeronautical designer.

Altogether this is a highly interesting and very valuable contribution to the literature of flying, and it will be welcomed by all who are desirous of making a serious study of flight from the engineering standpoint.

Share Market Report

London, February 13th, 1917.

Dealings in the shares of the various Marconi issues were somewhat restricted at the beginning of the month owing to the issue of the War Loan. There has been considerable buying during the past week, and the prices are well maintained. Prices as we go to press are: Marconi Ordinary, £2 17s. 6d.; Marconi Preference, £2 7s. 6d.; Marconi International Marine, £1 17s. 6d.; American Marconi, 16s. 9d.; Canadian Marconi, 9s.; Spanish and General Wireless Trust, 10s.

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Personal Notes

On behalf of our readers and ourselves we beg to express the deepest sympathy with Dr. Fleming in the sad bereavement he has suffered in the loss of his wife, who passed away on February 6th last. The personality of Dr. Fleming is so familiar that, with a large number of us, it is no mere matter of condolence, but a sharing of his grief.

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We deeply regret to announce the death of Charles William Pain, who passed away on January 22nd from a tubercular affection of the lungs. Mr. Pain entered the services of the Marconi International Marine Communication Co., Ltd., in 1912, and later transferred to Marconi's Wireless Telegraph Co., Ltd. On May 1st, 1913, he was appointed for duty at the Clifden Transatlantic Wireless Station and remained at that place until January, 1916, when he proceeded to London for the purpose of taking the position of instructor in the school for lady wireless operators organised by Marconi's Wireless Telegraph Co., Ltd. For some time prior to his death Mr. Pain had been receiving treatment and was at Niton, Isle of Wight, when the end came. Deep sympathy is felt for the late Mr. Pain's relatives in their sad bereavement.

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Several changes in the personnel of the Marconi's Wireless Telegraph Co. of America have been recently announced. Mr. Charles J. Ross, who for some time has held the position of auditor to the Company, now receives the title of comptroller; Mr. David Sarnoff, whose interesting contributions to our pages under the title of "American Letter" are well known to our readers, has been appointed manager of the Commercial Department; Mr. G. Harold Porter takes the position of assistant manager in the Commercial Department; and Mr. Lee Lemon has been appointed purchasing agent.

THE LATE MR. C. W. PAIN.

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George Payne, described as a wireless operator, and giving an address at Chatham, was recently charged on remand with obtaining 2s. 6d. by false pretences from

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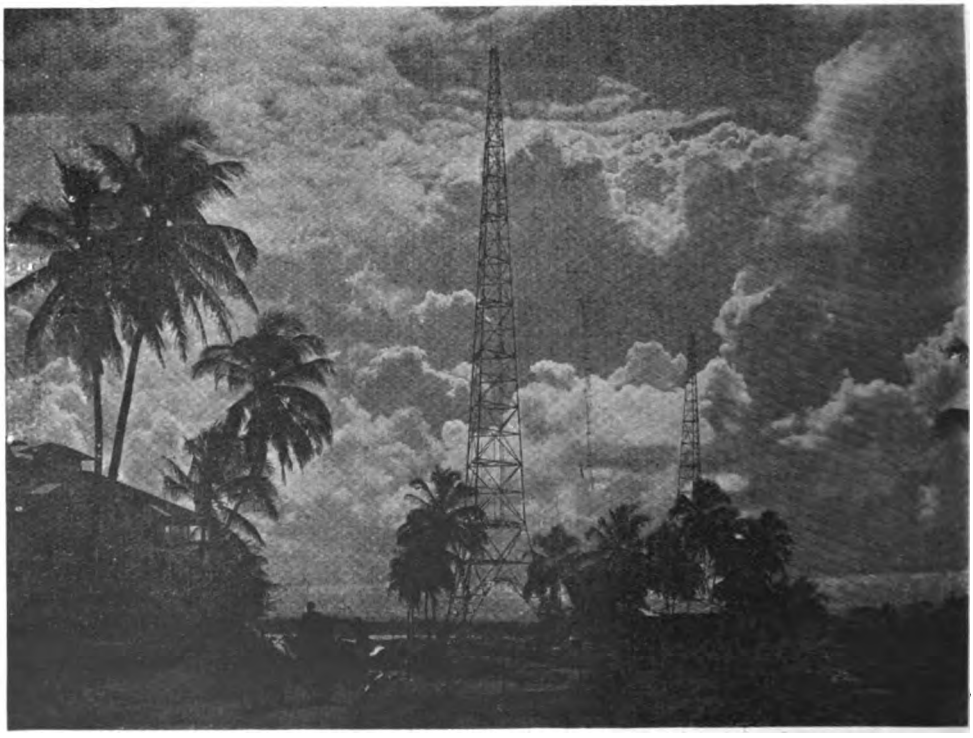
his landlady. A detective described the prisoner as a mean thief, and said he had been convicted 26 times. Payne was committed to prison for nine months. It should be pointed out that this man was never at any time in the employment of the Marconi Company.

* * * * * *

In the list of officers who lost their lives when H.M.S. *Laurentic* was sunk we find the name of Warrant Telegraphist Richard J. Thompson, R.N.R. Warrant Telegraphist Arthur Bower, of the same vessel, was fortunately saved. All wireless men will join with us in offering deep sympathy to the late Mr. Thompson's family in their terrible loss.

* * * * * *

Many of our readers will be interested to read that Mrs. Murray, wife of Mr. T. W. Murray, senior operator on an important liner of the R.M.S.P. Company, has been decorated with the Bar of Distinction by the Italian Government for service on the Italian front. She was serving there with the British Red Cross during 1915.



A MOONLIGHT VIEW OF THE WIRELESS STATION AT COLON, PANAMA. THIS STATION IS OWNED BY THE UNITED STATES GOVERNMENT.

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Pastimes for Operators

Model Making

In a previous pastime article emphasis has been laid upon the importance of cultivating the faculty of observation if success is to be attained. In nothing is this more essential than in model-making—a pastime pursued by a number of sea-going operators.

Under the general heading of model making we may place miniature shipbuilding, the construction of working models of steam engines, and a great deal of small electrical work including the making of wireless apparatus. Of the three, perhaps miniature shipbuilding is the easiest. The materials required are few, and, provided the aims of the constructor are not too ambitious, the expense is practically nil. Recently we had the opportunity of seeing a set of small reproductions of battleships, cruisers and torpedo boats, all constructed from pieces of wood by a member of the Marconi staff with such a faithfulness to detail that the models could profitably be studied by anyone interested in the trend of modern shipbuilding. Even supposing the models had no value in themselves—and this was far from being the case—the careful study of the disposition of funnels, guns, turrets and other details must have afforded a great fund of instruction and amusement to the ardent model maker, and given him a training in design of considerable value. There are many forms of aerial for instance most difficult to show in a diagram or drawing which are easily copied by small scale models between miniature masts. Land stations are even easier than ships to set up in diminutive form.

On a much more ambitious scale was a model recently constructed by an operator who had made a number of long voyages on a comparatively quiet route. In this case the model had practically every detail faithfully reproduced, deck fittings such as winches, ventilators, sky-lights and steam pipes being all in correct position and proper proportions. A steam engine and boiler concealed in the hull provided the motive power, and when finished the boat was so heavy that it taxed the strength of the proud builder to carry it off the ship !

A few words regarding the construction of the more detailed models such as that referred to will not be without interest at this juncture. It is a mistake to think that every tiny part has to be cut out and finished by hand. Deck fittings of every shape, size and form for model ships can be purchased from firms specialising in such things and are not expensive considering the care which is bestowed on their manufacture. Of course, it is much more interesting to make the details than to buy them, but a few judicious purchases will greatly lighten the labours of the constructor and leave him more time to devote to the hull and general structure.

Except in the smaller models, the hull is rarely cut out of a solid block, but is generally constructed of thin strips of wood shaped and fastened to a framework. A first essential is a set of good working drawings, to full scale, showing the plan and elevation of the boat and cross sections at various positions. If the operator is endeavouring to construct a model of his own vessel, he should have a chat with the

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chief engineer, who will be able to show him accurate blue prints of the vessel which will serve as a splendid guide in preparing the designs. In a general article we cannot more than indicate the main lines of working, and would recommend those who contemplate taking up this kind of work to purchase a small book on model shipbuilding. Several will usually be found advertised in our excellent contemporary, *The Model Engineer and Electrician*, a little weekly paper full of helpful articles for the model maker, and obtainable through any newsagent and bookseller.

A small spokeshave, a sharp knife and sandpaper will be used to shape and finish off the outside of the hull, the inside of which may be left rough unless an engine and boiler are to be fitted, in which case provision will need to be made for them. No attempt should be made to paint or varnish the hull until the work is practically finished, as a model has a great deal of handling during construction, and paintwork would be sure to be scratched if done too early.

Once the hull is finished a stand should be made, upon which the model can be placed while work is undertaken upon the deck and fittings. The masts will require great care if they are to make a good appearance, as any slight inequality is readily noticeable. Rigging is carried out with good strong thread, such as that used by bootmakers.

A brass or other metal tube can be made to serve as the funnel provided a piece can be selected of the right proportional diameter. In cases where the full-size funnel has bands which stand out slightly, these can be copied by gluing bands of thick paper round the tube before it is painted.

Except in very large models it is useless to attempt to inlay glass for portholes and skylights. Clear celluloid is a far more satisfactory material to handle, as it is thin and readily cut to correct shape. Handrails, if the model is sufficiently large to require them, had best be made from stiff brass wire ; softer wires are useless, as they get bent with the slightest handling. Capstans, winches, ventilators and the like, if not purchased ready made, should be cut and filed from scrap brass or copper, as iron or steel will rust in the sea air.

The final painting of the model must be most carefully done, or the whole effect will be spoiled. A number of very thin coats must be applied to obtain a perfectly smooth surface, each coat being allowed to dry thoroughly before the next is applied. The small tins of enamel sold at any oil shop are quite suitable for this work, if thinned down, and allow of small quantities being purchased.

One of the most difficult parts of the finishing of a model ship consists in the more delicate painting and lining. This requires a very steady hand and straight eye, and unless well done will ruin the whole appearance of the boat.

So far we have omitted any reference to the fitting of engines, because most operators will find quite enough to do in building a scale model without them. Some men, however, have made excellent boilers and engines, calling in the aid of the engineers on board for the more difficult metal work. A model fitted up in this way can be made to propel itself in ponds or other smooth waters, but will inevitably lack the beauty of the first type described, as the more delicate finish of rigging and deck work has to give way to the requirements of the mechanism. Further, a steam model is always " messy " owing to inevitable leakage of oil, water and spirit, and the paintwork is bound to suffer from the heat of the burners.

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Enough has been said to show that model shipbuilding is worthy of attention when considering what hobby shall be taken up. Some matter-of-fact people may ask what good purpose is served in spending so much time and trouble on what is at best a toy. The answer is that the pleasure derived from the construction of the model, the training in observation, the mechanical skill acquired, and the possession of a scale model of a modern boat are sufficient reward for the labour expended. The expert model maker, further, is in a much better position than his less skilled confrère to appreciate the beauties of modern shipbuilding.

A recent issue of the *Scientific American* contained an illustrated description of a most elaborate model ship, copied accurately from a well-known United States cruiser; it measured some six feet in length and was propelled by steam. The owner had spent some years in building the vessel, and lavished so much care upon it that when completed it was a perfect miniature of the giant vessel from which it had been copied. The guns were made to fire electrically, the model searchlights threw tiny beams in any direction at will, and even the launches were steam driven. The method of propulsion adopted for these latter craft is worthy of a brief description, as a similar means could readily be used in many other small vessels.

In each launch the boiler, which was made strong enough to stand a considerable pressure, had a small tube attached to it and led to the stern of the vessel. The tube terminated in a very small orifice, and when the boiler was heated a thin jet of high-pressure steam impinged upon the water, meeting therewith resistance, and forcing the boat along. There were thus no screws, wheels or reciprocating parts, and the boats could be made very light and tiny.

It is worth remarking that the whole vessel was built of metal, with the exception of one or two insignificant details. The tall lattice masts of the approved American pattern represented a great amount of labour, for there were hundreds of joints, all of which had to be soldered. Finally, the vessel could be steered from shore by wireless telegraphy. A description of the apparatus used will be published in a future number of the WIRELESS WORLD.

Still another branch of model making, and one which will particularly appeal to the wireless man, consists in the construction of small electric working models. These may range from the simplest and most crude motor to the elaborate multiple dynamo capable of running a battery of small lamps or even a miniature wireless set.

Take, for instance, the simple motor illustrated in the accompanying sketches. It can be constructed by practically anyone from old scraps of wood, metal and wire and will run merrily from a few dry cells. No sizes are marked on the sketches, as the details can be varied to suit the tastes of the constructor.

To make a start we must obtain a block of wood (A) to form the base and on this must be fastened an upright (B). A wood screw through the base will be found more satisfactory than glue. Next we have to procure a horseshoe shaped piece of *soft* iron (C) (bent iron rod will do), on which will be wound the two coils of fine wire (D_1 and D_2) which serve to magnetise the iron. To wind these coils neatly, take a lead pencil of the size of the iron rod, or any cylindrical piece of wood of the right thickness, and attach to it two discs of cardboard separated by a distance equal to the length of the coil it is desired to make (see illustration). If the pencil or rod is now rotated, the wire can easily be wound in place. When the spool is complete

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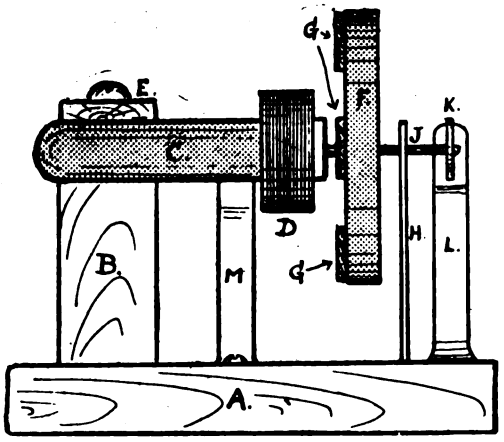


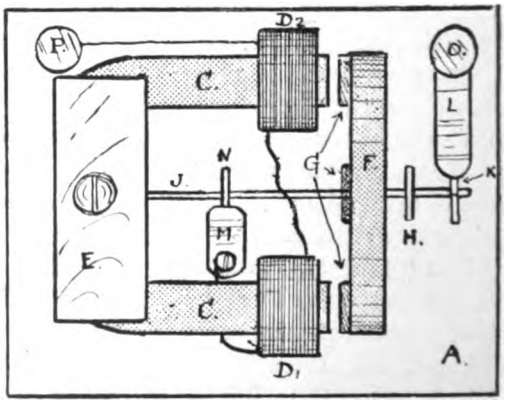
SIDE VIEW

the whole should be immersed in melted paraffin wax, the surplus wax run off, and the spool left to set. When cold the complete coil, in a solid mass, can be removed from the rod and slipped on to the iron pole-piece of the magnet. Two such coils will be required, one for each pole, and the two windings must be joined in series, care being taken that the magnetic effect is correct.

Having completed the magnet, the flywheel next engages our attention. This can be made from the lid of a tin, filled with lead if it is too light by itself. On this wheel are soldered, at equal distances apart, four pieces of soft iron so arranged that when the wheel is held in front of the magnet a piece of iron is opposite each pole. The wheel needs to have a spindle, which can be made from a stout metal knitting needle, and this must run easily in the support (H), and in (E), which holds the magnet down. A small square piece of brass (K) is soldered to one end of the spindle and a small brass disc (N) near the other. Two thin brass springs (L and M respectively) press lightly on these pieces of brass and serve to carry the current. Finally, two terminals (O and P) are required, O being connected to L, and P to one of the coils. The other coil connection is led to the spring M.

Let us now see how the model works. Current entering P will pass through the coil D1 and D2, magnetising the iron, pass through M to N, along the spindle to K, down L and back by O to the battery. Provided the position of K is properly set, and the pieces of iron G are not immediately opposite the pole-pieces, they will be attracted towards the poles. As soon as they arrive opposite the poles the circuit will be broken at K and the coils demagnetised. The momentum of the wheel will carry it forward until contact is restored at one of the points of K, and the action will then be repeated. These little motors attain very high speeds when carefully made and adjusted, but they provide very small power for driving other models.

A coat of paint will greatly improve the appearance of the finished motor, and indeed, if the woodwork be varnished, the iron magnet painted black and the coils and wheel red, the model will look very smart. Such motors are useful for studying the blending of colours by means of painted segments of cardboard discs.



PLAN

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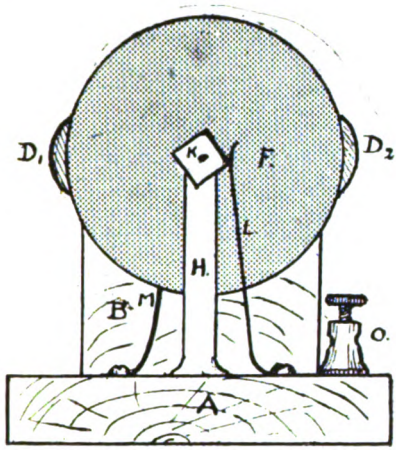
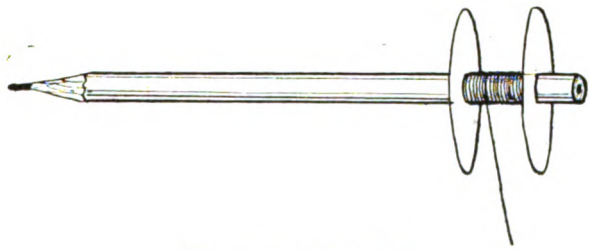


END VIEW

For particulars of more elaborate electric motors we would refer our readers to the many handbooks on motor building now obtainable. By the aid of castings, which can be purchased from several firms, some very fine motors and dynamos can be constructed quite inexpensively, but of course their construction takes time and care, and is not lightly to be undertaken.

At the same time, building small dynamos and motors constitutes valuable training and will help the operator to understand and appreciate the machine he is called upon to use in his daily work. A man who is skilled in the construction of model dynamos and motors will never be at a loss as to what to do in the event of a breakdown in the full-sized machine.

A few months ago (February 1916 issue) we published an article on building a model alternator by L. F. Isaac. Readers to whom the present article appeals should turn back to this and restudy it in the light of what we have said. We should also be glad to hear from subscribers who have constructed similar models.



WINDING THE COILS

Administrative Notes.

Spain.

A DECREE has been issued placing all wireless telegraph stations in Spain under official supervision, and henceforth they will be worked under State control.

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French West Africa.

Owing to present circumstances, it has been decided to close to public correspondence with ship stations, until further notice, all coast stations of French West Africa.

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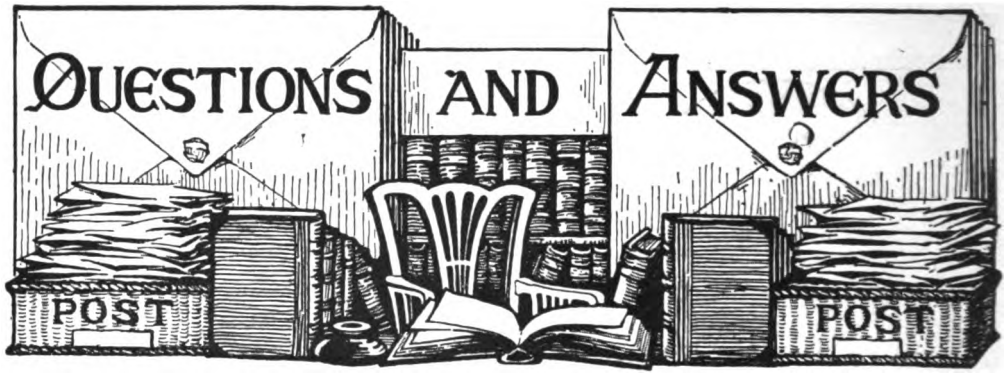

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor, THE WIRELESS WORLD, Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered: and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

NOTE.—*In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.*

A. F. H. (Bishops Waltham).—There are considerable differences of opinion on the subject of what is the best capacity of the condenser in the base of an induction coil. For example, the 10 inch coil made by some makers has a condenser of 1·25 mfd capacity, whilst others run down to 0·5. Provided the capacity of the condenser is not too small it may be varied within wide limits without objection, but if the platinum hammer break is employed it is better to err in the direction of using too much rather than too little capacity. Roughly speaking, the capacity of a condenser made with sheets of tin foil, separated by double or treble sheets of paraffin paper may be taken to be equal to 0·01 mfd. per square foot of effective tin foil surface (see Fleming's *Principles of Electric Wave Telegraphy and Telephony*, 3rd edition, page 53).

H. H. (Nelson).—(1) We cannot offer an opinion as to which service, the Marconi Company or the Navy, offers better prospects for an operator with a good education. So much depends on what arrangements are made in the Navy after the war. (2) Selected operators are taken when vacancies occur to fill positions as travelling inspectors, inspectors on shore, operators on foreign land stations, instructors, etc. The number of these vacancies is, of course, limited, and it is not possible to say exactly what pay attaches to the various positions. Everything depends upon the particular appointment and the ability and experience of the man in question. (3) It is quite exceptional for a wireless telegraphist in the Navy to rise to commissioned rank.

X. Y. Z. (Cardiff).—The Marconi Company employs only men who are physically fit and no applications are considered from men above 25 years of age. If you were rejected from the Army on the grounds you mention you would probably be rejected by the Marconi Company's doctor, even if you were under 25. (2) The wireless operators on practically all mercantile vessels are controlled by the Marconi Company. (3) We think it very probable that a French wireless company would reject you on the same grounds as those given above. We wonder that you did not ascertain before taking up a course that it would be very difficult to obtain any position if your age were above 25.

G. W. (Newcastle-on-Tyne) asks what we consider the length of time it would take an ordinary youth to gain the Postmaster-General's Certificate by (1) day classes, (2) evening classes, (3) correspondence courses.

Answer.—(1) Six months in day classes, if the youth works hard. (2) Probably ten to twelve months is the minimum. (3) As we have pointed out several times before, it is not possible to obtain the Postmaster-General's Certificate by correspondence tuition alone. In answer to your other question, there is no set standard of height and chest measurement for Marconi operators. They are simply required to be in sound health and physically fit. Naturally a man with a very small chest measurement could not be termed physically fit, and an extremely short man would not be able to carry out the work properly and would therefore not be accepted.

W. G. C. (Cheshire).—An excellent article dealing with the "Calculation of Logarithmic Decrement" appeared in our issue for December, 1915. In this we think you will find all the information you require. Should there be any other points on which you require enlightenment please write to us again.

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H. L. H. (London).—(1) We cannot say whether there will be many vacancies for operators in the Marconi Company in three months' time. The demand at present is very strong and we think it probable that it will continue for some months to come. (2) Yes, men with Second Class Certificates are taken at the present time. For conditions of service apply to the Traffic Manager, the Marconi International Marine Communication Co., Ltd. Marconi House, Strand, W.C. (3) Apply to Regent Street Polytechnic.

H. W. (H.M.S. ——).—A wireless telegraphist in the Navy can obtain the Postmaster-General's Certificate either by making application to the Secretary of the Post Office to be examined and passing the necessary examination at the place appointed, or he can be examined for this certificate by the naval authorities themselves. Why not apply to your superior officer, informing him of your desire? He will be able to give you more information than we can.

A. F. B. (Cheshire).—The fact that your right eye is practically useless even with glasses would debar you from acceptance in the marine operating staff of the Marconi Company.

J. L. (Stepney).—For some years it has been a rigid rule that no person other than a British subject is allowed to operate the wireless apparatus on board a British ship. At the present time, and ever since the outbreak of war, it has been necessary not only that the operator shall be of British birth, but also of British parentage on each side. In no circumstances is this rule relaxed. There is no reason, however, why, provided you become properly qualified, you should not obtain employment in a foreign wireless telegraph company. We would suggest that you apply to the Société Anonyme Internationale Telegraphie Sans Fil, Marconi House, Strand, W.C. Perhaps they might have something to offer you.

"INTER NOS" (Crosby).—As mentioned in reply to another correspondent, the operators on practically all British ships are in the employ of the Marconi Company, to whom we would suggest that you apply.

C. T. A. (South Wigston).—The answer to your first question is that the lines of force from the primary of a closed core transformer pass through a secondary winding in the same way as they do with an open core. You should remember that lines of force are generated round every turn of the primary. Question 2. We cannot tell you the use of the piece of apparatus you mention without seeing it. The particulars you give are not sufficient to identify it.

J. W.—To calculate the inductance of the coil of which you send a sketch there is no simple formula. The self-inductance of each layer can be obtained from a formula, and then by obtaining the sum of all the mutual inductances between the various layers, the inductance of the whole coil can be obtained. An approximate method which is simpler is as follows: Assume the coil to be replaced by a single layer winding, the diameter of which is equal to the *mean* diameter of the actual coil, and having the distance between turns equal to the distance between the sections of the actual coil. Calculate the inductance of the single layer coil by one of the methods given in previous issues of THE WIRELESS WORLD, and multiply by the square of the number of turns in each layer. The advantage of this coil is that it is more compact than an equivalent single layer coil, but on the other hand its self-capacity and therefore its dielectric losses are much larger.

C. E. S. C. (Manchester).—(1) The Iolanda switchboard is simply another name for the A. C. switchboard used on the 1½ k.w. Marconi installation. (2) We cannot say what line schools usually follow in their instruction. It all depends upon the particular school. (3) Yes. (4) No. (5) It is not usual to sell such portions of wireless installations to the general public.

G. I. (France.)—The subject which you are studying and on which you ask for information, the distribution of potential around an earth connection, is of too extensive and elaborate a nature for us to devote much space to it in these columns. You do not state whether it is the earth-system of a wireless aerial which you are considering, but if this is the case we do not see that the theory of the Morse, Lindsay, and Willoughby Smith system would be of much use to you, as this is a system of conduction telegraphy. The best account of the function of the earth in wireless telegraphy will be found in Dr. Fleming's "Principles of Electric Wave Telegraphy." You will also find some oscillograms of vowel-sounds in that work, but we do not know where a complete collection of these is to be found.

E. F. W. V. enquires what wave-form would be shown on an oscillograph connected to a circuit whose natural period is, say, 600 per second, when the circuit is connected to an alternator of 50 cycles per second, the oscillograph being in parallel with the condenser. He also asks the bearing of the above on the circuit of an asynchronous discharger wireless transmitting circuit.

Answer.—If the alternator has a pure sine-wave form of 50 periods then the oscillograph will record a sine-wave of 50 periods. The amplitude of the curve will depend on the voltage given by the alternator and the value of capacity and inductance in the circuit, *i.e.*, it will be different for a circuit of small capacity and large inductance from what it would be for one of large capacity and small inductance. This can be seen by calculating

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the impedance of these quantities for the frequency of the current. If the alternator has a wave form containing harmonics then the wave shown by the oscillograph will contain the same harmonics but their relative magnitude will be altered since the impedances of the circuit will be different for each frequency. Provided the wave form of the alternator is not changed in itself on connecting the load then the shape of the oscillograph curve may be calculated if the magnitude of each harmonic is known. When the frequency of one harmonic corresponds to the frequency of the circuit this will be greatly increased in the oscillograph wave. The circuit cannot of itself introduce a new frequency into the wave form, but can only change the relative magnitude of the frequency components. For the asynchronous discharger circuit the low frequency system is approximately tuned to the frequency of the discharge since this will give the largest current-flow in the circuit. But the wave form is very irregular due to the sparking (see illustration in Hawkhead & Dowsett, so that only approximate tuning is possible. The tuning is in this case only to assist the current flow, not to manufacture a special frequency.

M. F. (Dartmouth).—Your calculation of the capacity of the variable condenser is correct. The capacity and inductance of the aerial will be given exactly by the method of the article in the March, 1916, WIRELESS WORLD. The method given in the "Year-Book of Wireless Telegraphy, 1916," is exactly the same but is given graphically instead of in the form of a table. To calculate the capacity of the aerial from its dimensions the method given in Professor Howe's articles is quite suitable. The term $-0{\cdot}63$ in his first example is obtained as follows: Since the distance between the horizontal wire and the image of the vertical wire is considerable, and moreover the correction due to the effect between them is small, it is sufficiently accurate to calculate the potential between these by assuming the charge on the vertical image to be collected at its middle point and to take the distance from this point to the middle point of either half of the horizontal wire. This distance $= 158$ feet, or $158 \times 30{\cdot}5$ centimetres. As the assumed charge is 1 unit per cm. the potential

$$= \frac{\text{charge}}{\text{distance}} = \frac{-100 \times 30{\cdot}5}{158 \times 30{\cdot}5} = 0{\cdot}63$$

The quantity $-1{\cdot}27$ is twice the above, $0{\cdot}63$, since we have charges at the mid-points of the two halves of the horizontal wire. In the second example the quantities

$$\frac{100 \times 200}{336} \text{ and } \frac{100 \times 600}{336}$$

are obtained in the same way, 336 feet being the mean distance as before. To calculate the inductance of a coil in the detector circuit the usual formula

$$\lambda_m = 1885\sqrt{L \text{ mh}, C \text{ mfd.}}$$

is used. We are unable to go into details as to all your calculations of inductance of coils, as you can easily check them for yourself; from your letter it is evident you know the formulas and only need confidence in your results when worked out. For the inductance of a coil consisting of a number of windings separated by spaces on one former, the method given in the Instructional Article for May 1915, should be used. You will find the correct connections for a carborundum detector in "The Principles of Wireless Telegraphy," by R. D. Bangay, page 113.

SPECIAL NOTICE.

Readers will considerably facilitate the work of our Expert if they write their questions on one side of the paper only, and make their queries as clear and full as possible. Questions should be numbered for reference and should not exceed four.

APARTMENTS, special terms to Marconi Students *only*, 15 minutes by tube to "The Strand," good table, excellent references, 16/6 per week inclusive.—MRS. BARRY YORKE, 22 Hogarth Road, Earl's Court, London, S.W.

LADY seeks position as Wireless Instructor; fully qualified; excellent references.—Box No. 252, THE WIRELESS WORLD, Marconi House, Strand, London, W.C.

APARTMENTS.—One or two Gentlemen (operators, students or staff) could be comfortably accommodated as guests by member of Marconi staff. Nice house in pretty suburb within easy and speedy reach of Waterloo. 6d. return.—Write G. J. T., Box 41, THE WIRELESS WORLD, Marconi House, Strand, London, W.C.

WANTED, Instructor of Wireless Telegraphy. Must be well up on Marconi system and ineligible for military service. State wages required and experience.—Apply Box 255, THE WIRELESS WORLD, Marconi House, Strand, London, W.C.

THE YEAR-BOOK OF WIRELESS TELEGRAPHY & TELEPHONY.—We have had the opportunity of securing a few copies of earlier issues and can offer them as follows—
1914 edition, 12 copies only, 3/- post free United Kingdom 4/- Abroad.
1915 edition, 4/- United Kingdom; 5/- Abroad.
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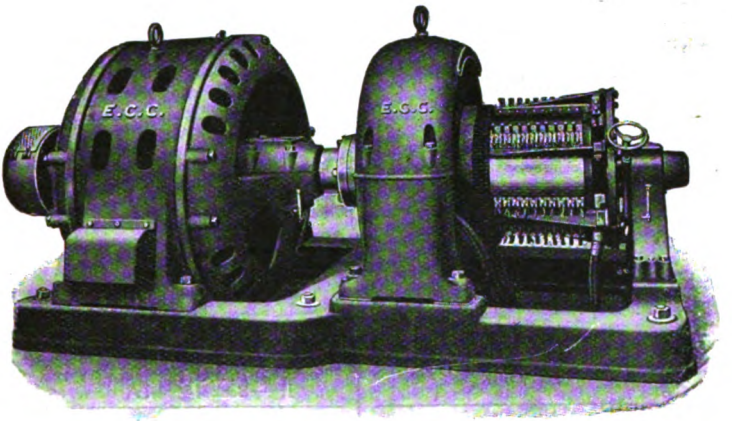

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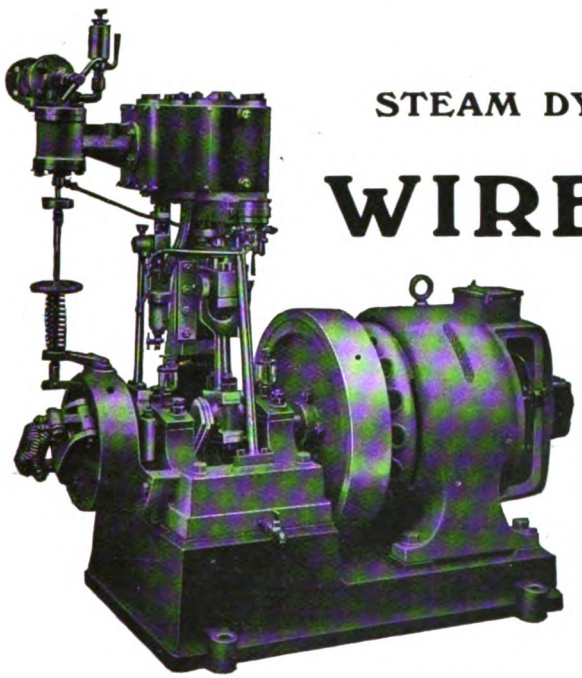

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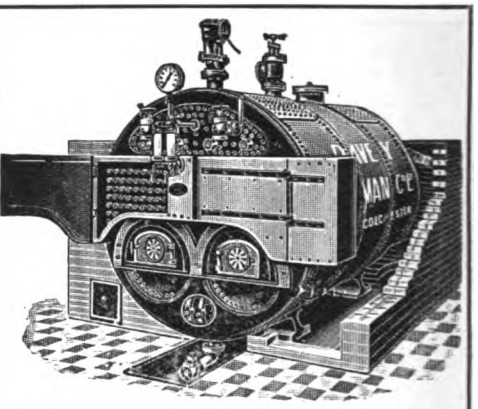

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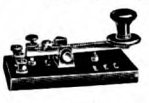
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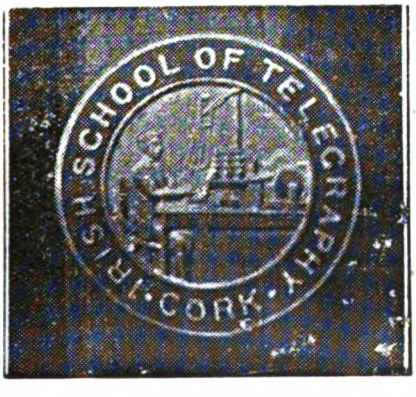

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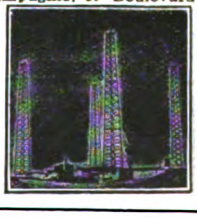

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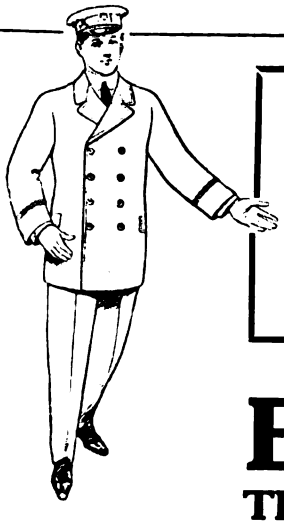

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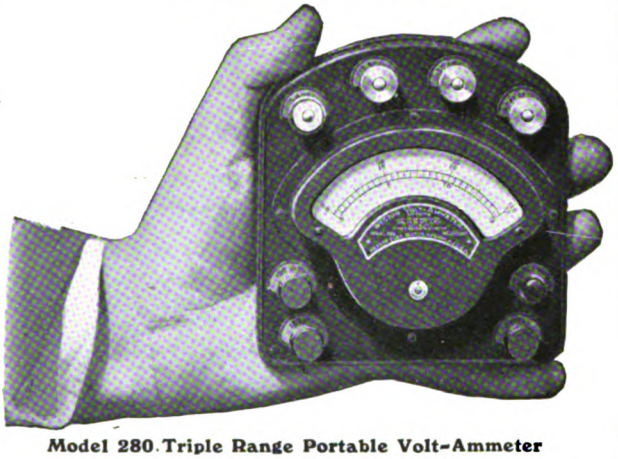

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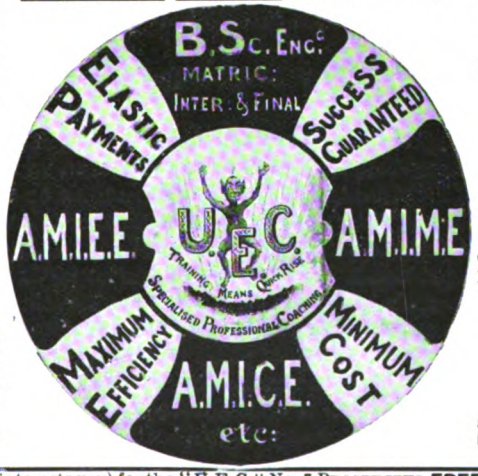

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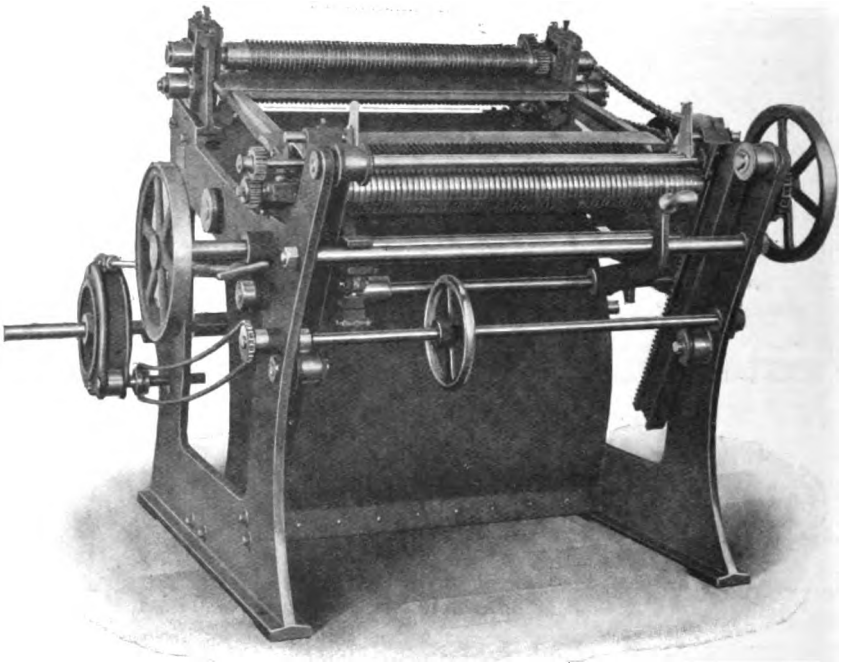

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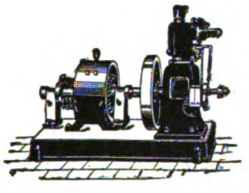

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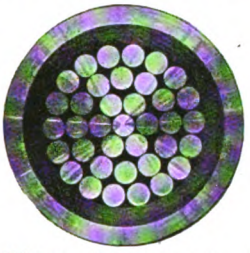

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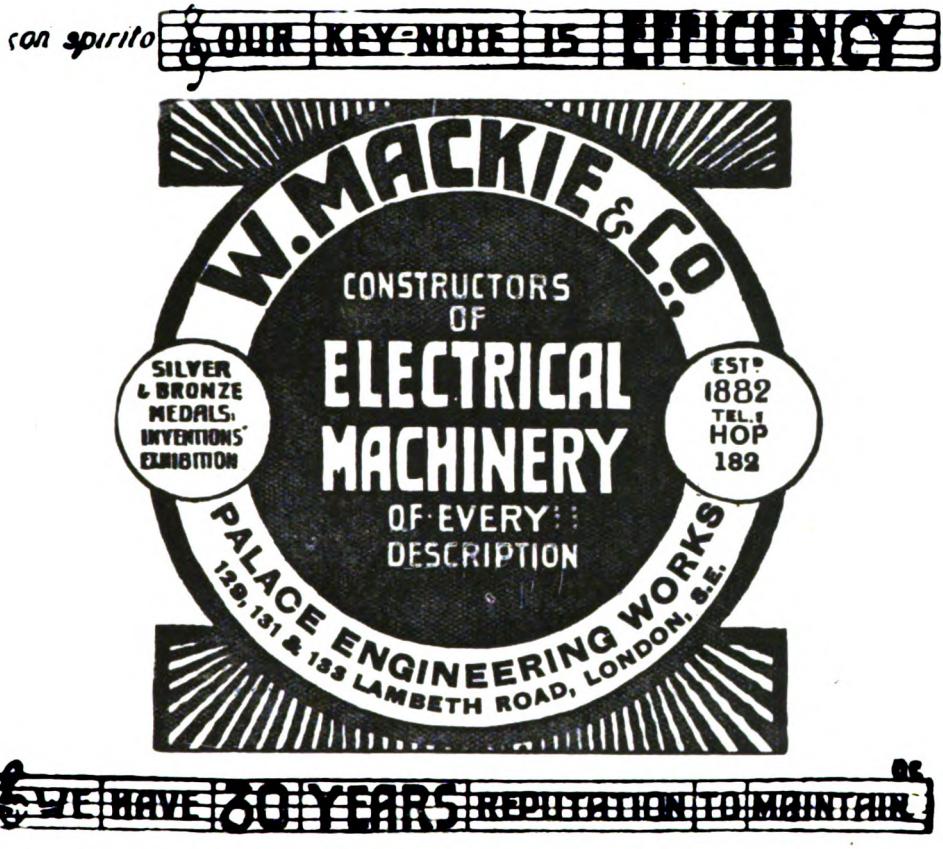

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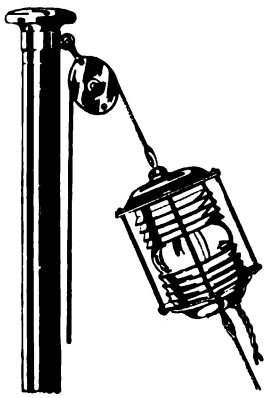

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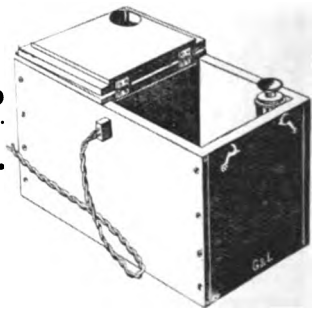

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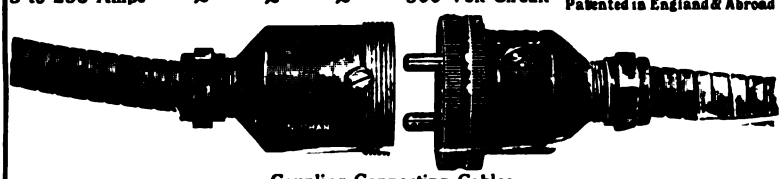

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